Conservation and sustainable use of biodiversity of fruit crops and wild fruit species

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Supported by the CGIAR.

ISBN 978-92-9043-914-1
УДК: 581.5+631.526

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This publication presents part of the findings of the regional GEF project "*In situ*/ on farm conservation and use of agricultural biodiversity (horticultural crops and wild fruit species) in Central Asia" implemented in five countries - Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. The project is coordinated by Bioversity International (IPGRI) with financing from the Global Environmental Facility (GEF), and implementation support from the United Nations Environment Program (UNEP).

Bioversity International is a research-for-development organization working with partners worldwide to use and conserve agricultural and forest biodiversity for improved livelihoods, nutrition, sustainability and productive and resilient ecosystems.Bioversity International is working towards a world in which smallholder farming communities in developing countries of Africa, Asia and the Americas are thriving and sustainable. Bioversity International focuses on rain-fed farming systems, primarily managed by smallholder farmers, in areas where large-scale agriculture is not a viable option. Its research influences policy decisions and investment in agricultural research, from the local level to the global level.
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Bioversity International's headquarters are near Rome, Italy, along with Rome-based UN food agencies FAO, IFAD and WFP. Bioversity International has regional offices in Colombia, Kenya and Malaysia. The organization, founded in 1973, has more than 300 staff and scientists worldwide working with almost 700 partners. www.bioversityinternational.org

Citation: Turdieva M.K., Kayimov A.K., Baymetov K.I., Mustafina F.U. and Butkov E.A. editors. 2012. Conservation and sustainable use of biodiversity of fruit crops and wild fruit species. Proceedings of International scientific and practical conference, 23-26 August 2011, Tashkent, Uzbekistan

Cover illustration: Harvesting of fruits on the experimental farm "Merkenskiy", photo by Bakyt Sauranbaev

ISBN 978-92-9043-914-1
УДК: 581.5+631.526

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Foreword

Central Asia is one of the most important Vavilov's centres of origin of cultivated plants, and the richest in specific and intraspecific diversity for many globally important agricultural crops. Cereals (wheat, barley, rice, maize, sorghum), food legumes (bean, chickpea), vegetables (tomato, potato, onion, garlic, coriander), melons, industrial, and stimulant crops (cotton, sugar beet, groundnut, sesame, tobacco) are cultivated in the region. Plant species in the region number 8,100; 890 of them are endemic. About 400 of them are listed in the IUCN "Red Data Book" as endangered.

Particularly important crops in Central Asia are the temperate fruit species. Apple (*Malus* spp.), apricot (*Armeniaca vulgaris*), peach (*Persica vulgaris*), pear (*Pyrus* spp.), plum (*Prunus* spp.), grape (*Vitis vinifera*), almond (*Amygdalus* spp.), pistachio (*Pistacia vera*), pomegranate (*Punica granatum*), and fig (*Ficus carica*) are among the best known crops cultivated in the region where, over the course of several centuries, the diverse natural and climatic conditions have helped farmers produce varieties adaptable to drought and resistant to a number of environmental stress factors. These locally-developed traditional varieties have been shown to be essential components of crop production in difficult environments.

Wild apple (*Malus* spp.), wild pear (*Pyrus* spp.), wild plum (*Prunus* spp.), wild almond (*Amygdalus* spp.), wild pomegranate (*Punica granatum*), wild grape (*Vitis* sp.), and other wild relatives of horticultural crops still grow and are cultivated in forests throughout the region. Many of them are used as rootstocks. Their resistance to biotic pressures – insects and disease – make them valuable genetic resources for reducing crop vulnerability on farm and providing genetic material for crop improvement. Many of these species are also important nutritional resources for local people.

Due to the collapse of the Soviet Union and the transition from a centralized economy to a market-driven one, the Central Asian countries – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan – faced serious development problems. These include food insecurity, poverty, and degradation of the environment. Issues of food security and poverty are pushing agricultural development and consequent biodiversity loss. While government efforts to restructure the agricultural sector and diversify production are ongoing, genetic erosion, including of fruit species, is on the rise. Important fruit species genetic diversity is found both in the wild and on farm; both sources are threatened by a number of factors.

Wild fruit species in Central Asia are under threat due to overgrazing, deforestation, logging and industrialization. The Central Asian countries have responded to these threats by establishing 15 forest reserves where wild fruit species grow. However, in many of these reserves, the fruits are used unsustainably by local people, thus contributing to genetic erosion. In addition, the best-quality products are selected to ensure better marketing opportunities. This engenders a human-driven natural selection, which leaves only those varieties that are not immediately marketable to reproduce. The result is loss of wild fruit species, and reduction of intra-specific diversity in natural forests and reserves.

The consequent degradation of natural habitats and biodiversity loss leads also to loss of a wide range of valuable ecosystem services (e.g., carbon storage, protection of hydrological functions, soil erosion), an instable environment, and, ultimately, natural calamities such as floods, drought, and landslides.

Horticultural crops face equal pressures. Since cultivation began, farmers have managed local varieties in a dynamic way to produce the most marketable plants, and those that have adapted the most effectively to local environmental conditions. However, while many valuable landraces and local cultivars of these species are still maintained in home gardens and on small farms, the introduction of uniform high-yield varieties, use of chemical fertilizers and pesticides, and increased mechanization have reduced the area of agricultural lands on which local cultivars are maintained. The result is loss of traditional diversity-based farming systems, arable lands degradation, pollution of the environment (water, soil, air), genetic erosion, and loss of biodiversity.

Action to conserve diversity of horticultural crops and wild fruit species is hampered by inadequate information about the value of these resources, lack of coordination between environmental protection and agricultural development agencies, and inadequate communication among local scientific institutes and local and national government agencies. Limited financial resources and inadequate institutional structures diminish the effectiveness of developing legal frameworks for protection of the environment. Information and knowledge on the number and quality of horticultural crops and their genetic resources, distribution, conservation, and use are inadequate. While knowledge on the wild resource exists, much of it is outdated and lacks benefit of modern technologies. Lack of an integrated approach among key actors – farmers and local communities, scientific institutes, government agencies, and the private sector – prevents effective intervention to conserve the resource.

In 2006 five Central Asian countries including Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan in collaboration with Bioversity International under financial and implementation support provided by the Global Environment Facility (GEF) and United Nations Environment Programme (UNEP) initiated a regional project "*In situ*/on farm conservation and use of agricultural biodiversity (horticultural crops and wild fruit species) in Central Asia" to address the above constrains. The project addressed the problem of inadequate information, coordination and knowledge, thereby contributing to the elimination of the other major barriers to conserving fruit genetic resources (unsustainable use of wild fruit species and loss of traditional diversity-based farming systems).

The national partners in Central Asian countries felt that there is a need to share the lessons learnt and good practices developed within the project with global community. For this purpose an international scientific and practical conference "Conservation and sustainable use of biodiversity of fruit crops and wild fruit species" was organized by the project team and hosted by Institute of Genetics and Experimental Plant Biology of the Academy of Sciences of the Republic of Uzbekistan on 23-26 August 2011 in Tashkent, Uzbekistan.

More than 80 scientists and development officers from Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan, Armenia, Azerbaijan, Georgia, China, Czech

Republic, Sri Lanka and Bioversity International exchanged results of their research and development projects on agrobiodiversity management, including policy issues, methodologies on assessment of agrobiodiversity distribution and diversity level, actions on increasing public awareness on value and importance of plant genetic resources, establishment of partnership and strengthening collaboration, building capacity of stakeholders to perform successfully their roles in plant diversity maintenance.

We hope that the papers included in this publication will help researchers, development agencies, farmers' communities in their work on sustainable management of crop biodiversity and making it available for future generations.

Editors

Section 1.
LEGAL FRAMEWORK AND ROLE OF LOCAL COMMUNITIES IN THE MAINTENANCE OF PGR DIVERSITY

IN SITU/On farm CONSERVATION AND USE OF AGROBIODIVERSITY IN CENTRAL ASIA: POLICY ISSUES AND BENEFIT-SHARING MECHANISMS

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The five-year GEF project "*In situ*/on farm Conservation and Use of Agricultural Biodiversity (Horticultural Crops and Wild Fruit Species) in Central Asia", which has been supported by UNEP and coordinated by Bioversity International, has had as a remarkable and distinctive feature, in contrast to other *in situ* projects, the development of a policy component that underlines the importance of analyzing existent legislation and policy to identify gaps and provide options to policy-makers for strengthening legal and policy frameworks that support the conservation of horticultural and wild fruit species genetic diversity. Additionally, guidelines to access and benefit sharing in research projects have been elaborated to provide national partners with instruments and agreements that could help them to share the benefits and products of the project among themselves and with third parties. In summary, an information-sharing agreement has been signed by national partners and Bioversity to ensure a continuous regional collaboration with regard to agrobiodiversity conservation.

The importance of considering policy issues within *in situ*/on farm projects in general lies in the fact that agriculture is essentially linked to rural populations' livelihoods. When we refer to agrobiodiversity conservation we are dealing with communities and collective relations of exchange and, from this starting point, we are viewing the issue in a social context and, therefore, in a policy context. It is as important to conserve fruit genetic resources *per se* as it is to protect the farmer who uses agrobiodiversity for his/her livelihood as well as the traditional knowledge and practices related to it.

On farm fruit genetic resources conservation is impossible without local communities' or farmers' approval and action. Farmers' decisions to maintain traditional varieties demand policies that build upon the socioeconomic circumstances in which they interact: land tenure security; availability of planting material; freedom to farm; management capacities; local institutions; and markets for diversity-rich products, among others. Therefore, farmers' decisions on conserving and exploiting landraces and wild fruit species should be considered in a social and economic context and, in this scenario, top-down policy decisions and regulations can be counter-productive. Farmers´ rights and farmers´ freedom when making cropping choices equally builds upon a given institutional framework that defines the exchange and movement of plant genetic resources and information.

The five-year GEF project "*In Situ*/On farm Conservation and Use of Agricultural Biodiversity (Horticultural Crops and Wild Fruit Species) in Central Asia", which has been supported by UNEP and coordinated by Bioversity International, has considered the importance of analyzing existent legislation and policy in the five Central Asian Republics to identify gaps and provide options to policy-makers for strengthening legal and policy frameworks that support conservation of horticultural and wild fruit species genetic diversity.

To this aim, Central Asian countries have focused their research on legislation and policies in relation to three thematic areas of agrobiodiversity conservation: strengthening farmers' management; the conservation of local varieties; and farmer's rights. For this purpose, national partners have revised existing legislation on protected areas, forest legislation, endangered species, land reform and farm development, among other issues that critically affect *in situ* and on farm conservation. Having identified existing gaps, policy and legislation proposals have been elaborated that demonstrate the need to protect Central Asia fruit crop diversity and to strengthen farmers´ roles in its conservation and sustainable management. As a consequence, traditional diversity-based systems have been better understood at all levels and more recognition has been given to farmers and communities regarding *in situ*/on farm agrobiodiversity conservation.

In relation to agrobiodiversity conservation, it has been the loss of mountain ecosystems, which are hotspots of fruit and nut forest diversity, that has led countries to think of stringent regimes for their protection *in situ* through the declaration of national parks and natural reserves and the identification of the most valuable forest species. The GEF project has contributed to giving higher priority to wild fruit species biodiversity when deciding the location and expansion of certain protected areas to protect fruit genetic diversity. It has also contributed to surveying community conservation areas outside protected areas that play a major role in maintaining genetic material of agricultural value. Proposals for Forest Code revisions to include the "genetic diversity conservation component" have also been made, in essence making the consideration of nut and fruit forest genetic resources a matter of prioritization in forest management.

Regarding species protection, as a result of the project, proposals have been formulated for strengthening the protection of wild fruit forest species through their inclusion in the "Lists of most valuable tree and shrub species" established under the scope of legislation on forests (species categorized as "valuable" deserve special attention in conservation, as the species not included as valuable may be subject to felling). In cases of extreme vulnerability, species are protected through their insertion in the Red Data Books of endangered and threatened species. A common feature in conservation policies is the need for awareness-raising among decision makers and different stakeholders on the importance of agrobiodiversity. This calls for increased efforts to create consciousness among stakeholders of the concept and importance of *in situ* conservation of wild species of economic value and of their great relevance for local food security.

Although Central Asia is a center of origin and diversity of fruit crops, as reflected in the rural identity and culture of the local populations, this has not been given proper consideration in agricultural sector regulations. Therefore,

the importance of the project lies in allowing national authorities to think of their national legislation under a new "genetically diverse"-and-"farmers´ rights"-perspective and allowing them to identify gaps and elaborate normative proposals. As a result, main initiatives have focused on modifying different aspects that are linked to fruit diversity conservation and farmers 'rights implementation at the national level: proposals on *dekhkan* farm legislation to promote long-term leases of land; land tax exemption in case of being dedicated to cultivation of local or old varieties of fruit crops and grapevine; economic subsidies to support local landraces; and farmers' responsibility in conservation. This has resulted in the elaboration of draft legislation on plant genetic resources conservation and farmers' rights implementation. Also, the notion of farmers as breeders has been given recognition through proposals to certify farmer-bred varieties by State Variety Testing Commissions prior to release and patenting. Registers of local varieties and traditional knowledge has been developed towards farmers´ rights implementation in the five countries.

The consolidation of this system of local varieties, conservationist farmer registries, together with a network of nurseries and demonstration plots, will enhance the access and exchange of seed, saplings and rootstocks among farmers, forest dwellers and scientists. The recognition of this system at national Ministries of Agriculture and Environment will help to further institutionalize plant genetic conservation and influence policy making. This will be strengthened through new proposals on the creation and legal recognition of farmers' associations and communities towards fruit crop production and through the institutionalization of farmers´ fairs.

At the same time, national partners (with the idea of protecting farmers' rights, and exploring ways through which the benefits derived from the use of genetic resources can be shared with the farmers that conserve them *in situ*) identified different benefits and products as a result of the project. In addition, the project identified possible beneficiaries and outlined the conditions of free and restricted access under which these benefits and products should be shared among project partners and with third parties. National partners also underlined the need to come up with different access and benefit sharing tools that could deal with all these different relationships. The "*Guidelines: Access and Benefit Sharing in Research Projects*" have been elaborated and will be published in response to this demand and to facilitate collaboration among national parties with different agreements that can help them in their relations of access and benefit sharing in the context of the *in situ*/on farm project.

Additionally, as a result of the project, a database on crop varieties and wild fruit species was created, together with the development of information of a very different nature (training materials, technologies for orchard management, names of conservationist farmers, list of nurseries, scientific publications, among others). An agreement was required to enable a continuous relationship of exchange and cooperation among project partners, and also defining their conditions for third party beneficiaries' access and use of the information. In practical terms, a website has been created with different levels of access according to the categories of information designated by the parties as open or restricted to third

parties. In legal terms, an information-sharing agreement has been signed by national partners and Bioversity to ensure a continuous regional collaboration so that existing linkages among institutions continue in the future with regard to agrobiodiversity conservation.

SOME ISSUES OF FARMERS' INTELLECTUAL PROPERTY RIGHTS PROTECTION

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The GEF project "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia" supported by UNEP and coordinated by Bioversity International pays close attention to farmers' intellectual property rights protection. The most important rights include those for acquiring intellectual property rights on crop varieties bred and used by the farmers.

Law No.395 "On breeding achievements" dated 29.08.2002 and Law No.267 "On seed production" dated 29.08.1996 were enacted in Uzbekistan; they protect farmers' interests in intellectual property on crop varieties bred by the farmers themselves (Tashkent 1998; 2010).

A new plant variety is considered a breeding achievement in plant improvement. Any variety belongs to a specified botanical variation of a certain species. At the same time, the variety is not and cannot be a botanical systematic unit (Law on *Breeding Achievements*, 1996).

In contrast to annual crops (cereals, vegetables, some industrial crops) fruit crops are perennial plants. They reproduce in a vegetative way, which ensures full constancy of the offspring with regard to economically valuable traits. That is why in fruit production a variety is a clone of genetically homogeneous offspring derived from a single initial individual through vegetative reproduction. Vegetative reproduction ensures homogeneity and stability of the offspring with regard to selectable traits.

The organizational basis for legal protection of breeding achievements (Article 4 of the Law "On breeding achievements") was established in Uzbekistan. There is a patent office which accepts and reviews applications for the granting of patents for breeding achievements. This office conducts an expert examination, keeps a State Register of Plant Varieties and issues patents.

The State Commission on Agricultural Crop Varieties, which comes under the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan, conducts an expert examination of the patentability of the claimed breeding achievements. The author of the breeding achievement is a physical person whose creative work established (bred or revealed) a new plant variety and the author is thus granted a patent for the breeding achievement (Article 5 of the Law

"On breeding achievements"). In this manner, the legislation does not distinguish between different categories of a physical person. Any farmer who has created a new plant variety can become an author. In cases when several physical persons participated in a breeding achievement creation, the legislation recognizes them as co-authors.

Project activities provide for farmers' participation in joint research work. In this respect joint participation in breeding programs is the most promising; program participants can become co-authors (authors) of patents and all publications related to breeding achievement.

During research work in cooperation with farmers, especially during the creation of new fruit crops varieties, a contract should be drawn up and signed which reflects mutual relations between a farmer and an academic institution. It should be stipulated who is a patent holder and what are the terms for compensation allocation.

Breeding achievement must match the following criteria: novelty, distinguishability, homogeneity and stability (Article 8 of the Law "On breeding achievements"). A breeding achievement is considered new (Article 9 of the Law "On breeding achievements") if up to the day of submission of an application for a patent the variety seeds and planting material have not been sold and transferred to other individuals by the author, his heir or by their appropriation for use on the territory of the Republic of Uzbekistan within less than one year before that date.

Breeding achievements must have distinguishability. Article 10 of the Law "On breeding achievements" describes distinguishability criterion as follows: on the day of submission of an application for the granting of a patent, the breeding achievement should clearly differ from any other well-known breeding achievement. In this respect republican academic institutions on fruit production and viticulture – the R.R. Shreder Research Institute of Horticulture, Viticulture and Winemaking, the Uzbek Research Institute of Plant Industry and Research and Production Centre of Ornamental Gardening and Forestry – must provide advisory assistance and help in obtaining the documents required for submission of the breeding achievement (variety) to the State Commission on Agricultural Crops Variety Control. A breeding achievement is considered well-known if on the date of submission of the application for a patent for this achievement in any country, some form of protection document is issued or provided, or the breeding achievement is listed in the register under the same name of breeding achievement in this country.

As for homogeneity and stability of breeding achievement, in the case of vegetatively reproduced fruit crops, under the observance of rules (testing of stool-beds and nurseries) selectable traits must meet the requirements of the patent receipt.

If a breeding achievement (variety) matches the criteria of patentability, a patent is issued on it which certifies novelty, distinguishability, homogeneity and stability of the breeding achievement as well as the right of the patent holder to name, own, use and dispose of the breeding achievement (Article 14 of the Law "On breeding achievements").

If a breeding achievement (plant variety) is created, then an application for the granting of a patent is submitted by the author (co-authors), employer or their

transferee to the patent office (Article 16 of the Law "On breeding achievements"). This implies that a farmer can personally submit an application for the granting of a patent as it is stipulated in the contract, which is usually drawn up before the research work on breeding achievement creation starts.

Article 17 of the Law "On breeding achievements" describes the contents of the application for the granting of a patent. All requirements are quite feasible except for one item. An applicant must provide documents on breeding achievement tests conducted personally or in cooperation with co-authors. In this case, an academic institution must conduct new variety testing according to the methodology and requirements of variety control.

The breeding achievement undergoes state examination (Article 19 of the Law "On breeding achievements") which includes formal examination for patentability, consisting of novelty, distinguishability, homogeneity and stability tests.

Examinations of a breeding achievement claimed are conducted according to the methodology and within a period set by specialized organizations at state variety control stations, state variety control plots, or in other organizations on the list of approved by the Cabinet of Ministers of the Republic of Uzbekistan. In our view, examination of the claimed breeding material can also be conducted at demonstration plots according to methodology of the State Commission on Agricultural Crops Variety Control. And in this case the work should be done in close cooperation between farmers and researchers.

A patent holder must support a variety during the life of the patent so as to preserve traits specified in the official description of the variety composed on the date of its registration in the corresponding registry. This means that there must be parent trees for every variety. In our view it is better to plant parent trees at demonstration plots.

In case of a farmer breeding a new variety and obtaining a respective patent, the farmer has a right to organize a fruit crop nursery and grow fruit crop seedlings for sale. This means that a farmer must introduce an efficient seedling production system at his nursery, provide descriptions of reproducing varieties and produce high quality products – fruit crop seedlings. Seedlings grown in the nursery are to subject to certification in accordance with the procedure established by the legislation.

It can thus be seen, through the analysis of the Laws "On breeding achievements" and "On seed production," that the laws provide full support and protection of farmers' intellectual property.

The organizational framework for the legal protection of breeding achievements has been established in Uzbekistan. There are a Patent Office and a State Commission on Agricultural Crop Variety Control, both of which operate under the Ministry of Agriculture and Water Resources of the Republic of Uzbekistan.

Any farmer who creates a variety can become an author of a breeding achievement. He/she can become a co-author if several individuals participated in the creation of the breeding achievement.

In general, the Law "On breeding achievements" protects farmers' intellectual property and offers an opportunity to work fruitfully on new fruit crop variety breeding. Examinations of a claimed breeding achievement are conducted

according to established methodology and within a period set by specialized organizations at state variety control stations, state variety control plots, and in other organizations, the list of which is approved by the Cabinet of Ministers of the Republic of Uzbekistan.

The following recommendations were developed as part of "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia" project:

- it is recommended that an examination of a claimed breeding achievement is conducted at demonstration plots following the methodology of the State Commission of Agricultural Crop Variety Control;
- it is recommended that variety control activities are conducted in close cooperation between farmers and researchers.

A patent holder must support a variety during the life of the patent so as to preserve traits specified in the official description of the variety composed on the date of its registration in the corresponding registry. This means that there must be parent trees for every variety. We recommend planting parent trees at demonstration plots established within the framework of the GEF "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia" project supported by UNEP and coordinated by Bioversity International.

The following scheme is recommended for acquisition of patent for breeding achievement:

- breeding achievement "varieties" bred or "sorted out" by a farmer;
- transfer of a breeding achievement to academic institutions dealing with fruit crops to obtain confirmation of its novelty and distinguishability;
- testing of the breeding achievement by the applicant;
- transfer of the breeding achievement to the State Commission on Agricultural Crop Variety Control;
- examination of the breeding achievement's patentability;
- acquisition of a patent;
- reproduction of the breeding achievement (establishing mother plantations of the breeding achievement, certification of seedlings);
- sale of seedlings.

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ROLE OF HOUSEHOLD ORCHARDS AND FARM ENTERPRISES IN AGROBIODIVERSITY CONSERVATION

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The earliest fruit crop cultivation dates back to the prehistoric period. At first, fruit trees were produced mainly through growing trees from seeds, the best of which were further reproduced through inoculation and became founding varieties for traditional breeding (Isaev 1966).

Tajikistan is the land of the most ancient primary agriculture that, despite all historical trials, has retained to our times most, if not all, of its achievements. Excellent varieties of apricot, apple, pear, mulberry, walnut, etc. are evidence of this (Popov 1935).

The density and unique collection of fruit crops and grape varieties and forms is explained by the complex orography and soil and climatic conditions of the landscape. In addition, the Silk Road allowed the introduction of seeds of the best varieties from such countries as China, Afghanistan, Iran; fruit mulberry, apricot and other crops whose wild relatives were absent in the country were imported to Tajikistan.

All local varieties always served as sources of glucose, oil, vitamins and proteins as well as a substitute for bread in hard times. Every historical period was either an impetus to increased prosperity in horticulture and viticulture or the reason for their decay, which resulted in many varieties and forms disappearing forever.

In the twentieth century the structure of agriculture in Tajikistan changed drastically. Cotton, food mulberry and citrus plants became leading crops in valley regions; tobacco, grains and potatoes in mountainous regions. The mass migration of people from mountainous areas to valleys in 1930-1950 also caused the degradation of local fruit crops varieties and forms. Starting from the 1930s, endemic varieties of apple, pear, peach, plum and sweet cherry as well as wine grape varieties have replaced up to 100% of local varieties and have become a main production of industrial plantations in Tajikistan. Not all varieties that had been introduced, despite high quality fruits,were able to adapt to local conditions and went out of production. It is appropriate to remember the statement of Ryabov (1967) that “Local varieties of fruit crops are diverse and valuable because

of their quality and traits. They disappear gradually and are replaced by a limited set of new varieties. This leads to the disappearance of our national richness in the form of the most valuable genetic resources of plants. Therefore, all possible measures should be taken for their conservation" (Ryabov 1970).

The results of field studies conducted by geobotanists, fruit producers and foresters from the 1930s to the present have shown that intraspecific diversity of local fruit crops is very rich; the primary conservation reservoir of this richness (genetic resources) are farmlands and other areas of husbandry.

Every breed has generally recognized varieties that form the foundation for industrial horticulture. For example, apricot varieties – Khurmoi, Boboi, Kandak, Mirsandjali, Isfarak, Subkhoni, etc.; pear varieties – Dilafruz, Nok Garmskiy and their clones, Noshvati zimnyaya; grape varieties – Tayfi rozoviy, Nimrang, Djaus (Sultoni), Khusayne beliy and Khusayne cherniy, Kishmish beliy and Kishmish cherniy, etc. Numerous varieties are found as sporadic specimen in Tajikistan's farmlands.

As a result of long-term studies and with financial support from the GEF "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia" project, supported by UNEP and coordinated by Bioversity International, field studies have sorted out and described more than 300 accessions of apricot, more than 100 accessions of apple, 50 accessions of pear, 40 accessions of fruit mulberry, 90 accessions of walnut, 80 of grape. More than 75% of mentioned samples are conserved on farmlands. The Institute of Horticulture and Vegetable Growing of the Tajik Academy of Agricultural Sciences conserves 160 accessions of apricot, 60 of apple, 28 of fruit mulberry, 75 of walnut and 24 local accessions of grape.

There is no doubt that traditional knowledge of the local population influences fruit crop agrobiodiversity conservation. From one generation to another, the farming population transfers its traditional knowledge and experience in fruit tree cultivation and use of their fruits. Normally, they grow fruit crops by sowing seeds and then using various grafting methods on grown seedlings of selected varieties (ring budding, cleft-graft, chip budding, etc.). In mountainous areas 5-6 year apple and pear seedlings dug out in the forest are used instead of seeds; they are planted in the designated place and the same method is used in grafting with better fruit varieties. Many farmers graft forest fruit species to improve forests. For example, farmer K. Murodov, living in Djavoni rural council in the Fayzabad District conserves six local apple varieties of various ripening terms and three walnut forms. Farmer Rivodja from Nimich village of Rasht District conserves three apple varieties – Rukhsoram, Shafe'I, Khuboni; three pear varieties – Noki Garmi, Tobistona and Noshpoti zimnyaya; three apricot varieties – Kandak, Safedak and Djavzapak.

Market demand for local fruit crops varieties has increased during the past ten years. Farmers' interest in local fruit crops varieties, especially apple, pear, grape is increasing too. According to the latest statistical data, small farm households and home orchards produce 67,8% of horticultural products in the Republic. There is therefore a need for all-round support to amateur and farmer gardeners who conserve and reproduce local fruit crop varieties using traditional knowledge.

It is necessary to provide them with information to enhance their knowledge about local fruit crop agrobiodiversity cultivation, conservation and use technology in Tajikistan.

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TOWARDS LEGAL PROTECTION OF WILD RELATIVES AND ANCIENT VARIETIES OF FRUIT CROPS IN TURKMENISTAN

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Agrobiodiversity (*agricultural biodiversity*) – a component of the traditional lifestyles and national culture of *daykhan* (farm) enterprises in Turkmenistan – is one of the components of intellectual property of local populations. For the first time the thesis of farmers' rights protection has been considered in the form of a legislative initiative "*On farmers' rights protection, measures of farm enterprises support and mechanism of benefits sharing in fruit crops and their wild relative cultivation in Turkmenistan,*" which was prepared within the framework of Bioversity International's "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia" regional project.

Unfortunately, the legal framework of Turkmenistan lacks a component on rights protection for farmers and farm enterprises that cultivate fruit crops and their wild relatives. Seeds of fruit crops wild relatives as well as domesticated wild species or traditional "old" varieties from local breeding are, according to the law "On seeds," not included in the State Seed Registry of the Patent office of the Ministry of Economics and Finance of Turkmenistan. Therefore, to conserve the gene pool of local fruit crops it is important to consider farmers' (*daykhans'*) right to act as an equal party in benefit sharing, including the right of farmers to participate in decision making on the issues of access to plant genetic resources which are used in food production and farming (UNEP 1992; FAO 2001).

The basis of farmers' rights is a portfolio of traditional knowledge that is made up directly from the knowledge of farmers and their ancestors with regard to the cultivation of ancient fruit crop varieties and their wild relatives; this knowledge is transferred across generations. As it is commonly known, the demand for certain varieties and their properties depends on market development, variety characteristics and cultivation and storage specifics. The vitality of every variety is determined by the integrity of its local gene pool, i.e. characters that identify this particular variety. Ancient or improved new varieties are the intellectual property

of local populations, a part of their traditional knowledge. The increasing rate of importation to the markets of our country of foreign seeds of genetically-modified vegetable plants such as tomatoes, cucumber, garden radish, bell pepper and eggplant as well as apple, pear and plum fruits has significantly forced out ancient varieties of Turkmen origin from local markets.

Therefore, legal support to farm enterprise development is required to conserve the gene pool of fruit crop wild relatives and state monetary grants are necessary to enable farmers to make decisions about the maintenance of the genetic diversity of traditional local fruit crop varieties. These grants will allow the enhancement of market-based incentives and assist in conserving local varieties. Legal support to farmers will be aimed at conserving plant resources gene pools in the country both in natural habitats (*in situ*) and outside of them (*ex situ*).

Wild relatives of 172 species took part in the development of numerous cultivated plant species. Overall, 54 food crops are cultivated in the agronomy sector of the country that are included in the List of International Multilateral System of Access and Benefit Sharing of the Regional Strategy of Plant Genetic Resources Conservation, Replenishment and Use (FAO 2001; CATCN-PGR 2007).

Fruit crops include local varieties of cultivated forms of sub-endemic species of Asian wild apple (*Malus sieversii* ssp*. turkmenorum*), plum (*Prunus*), grape (*Vitis*), wild forms of "green gold" pistachio (*Pistacia vera*), common almond (*Amygdalus communis*) – progenitor of cultivated almond species—and pomegranate species under threat of disappearing (*Punica granatum*) of tropical origin. In isolated canyons the gene pool of walnut (*Juglans regia*) local populations – the bread of the future – is conserved. For example, cultivation of ancient local varieties of "babarabian" apple began as early as –the fifth or fourth centuries B.C. in Kopet Dagh since the time of the Parthian Empire, wild remains of cultivated grape (*Vitis vinifera*) varieties and ancestors of wild grape (*V. sylvestris*) have been conserved and established a great diversity of varieties in the process of natural and artificial crossing.

In area-specific centers a local grape collection has been formed from genuinely wild grape, numerous forms close to cultivated vine varieties as well as transitional and hybrid forms and wild cultivated varieties. Also, 94 wild forms and 42 varieties of common pomegranate have been sorted out; they were derived from pomegranate of Turkmen origin.

In the canyons of the southwest Kopet Dagh there still grow domestic garden plum (*Prunus domestica*) and wild alycha (*P. cerasifera*), which is considered by the experts the progenitor of *Prunus cerasifera* subsp*. turcomanica* variety.

Unfortunately, protection of traditional knowledge and derivation of benefits from using plant genetic resources of Turkmenistan is not reflected in any of the effective national legal documents (UNEP 1992; CATCN-PGR 2007). However, in Turkmenistan during the years of independence, a process has been activated on forming a regulatory framework to enable the creation and operation of market relations in the country. Thus the Law "On governmental support to small and medium business" (2009) established farm enterprises as business entities with the right to receive loans to purchase fixed and floating assets.

Farmers on their farmlands and small farm enterprises still continue to grow cultivated varieties of local fruit breeding crops. To protect this unique genetic potential of fruit crops from market competition with imported products and from exportation out of the country, protection of farmers' rights over their traditional knowledge needs to be ensured. By law a farmer has the right to cultivate local varieties and fruit crop wild relatives in his farm enterprise. He has the right to the products made, right to income generation and its utilization at his discretion without paying sales tax. Effective legal acts of recent years have improved conditions of farm enterprise operation, having supplemented the agronomy sector with fresh vegetable and fruit production for local market needs. But all this is not sufficient. A legal environment needs to be established in the country to support and further develop farmers and their farm enterprises for the cultivation of local varieties of fruit crops and their wild relatives in their natural habitats. For this purpose, it is necessary, based on the implementation of farmers' rights, to ensure economic incentives for farmers by establishing outlets for local products and providing material and technical assistance to local farmers cultivating local varieties and fruit crops and grape wild relatives in their farm enterprises.

Farmers' rights include:

- legalization of farm enterprises' right to participate in fruit crop wild relative conservation and their sustainable use in protected and forested natural areas;
- establishment of legal norms for the protection of forest genetic resources of fruit crop wild relatives, focusing on their conservation, protection and recovery;
- development of legal frameworks on protection of farmers' rights on intellectual property of breeding achievements, ensuring access to genetic resources and benefits from their use including legal protection of traditional knowledge.

The major element of the legal system for traditional knowledge protection is the farmers' right to cultivate traditional ancient varieties of crops and wild species in their farm enterprises. As a rule, market business does not encourage a farmer to cultivate ancient and less "saleable" crop varieties in his/her farm enterprise. Therefore, governmental monetary grants can enhance market incentives for farmers to cultivate traditional local varieties.

Legal protection of rare and wild plants' potential, popularization and reintroduction in farm enterprises allows Turkmenistan to ensure their conservation for further breeding of new varieties, becoming a barrier to the process of impoverishment (or loss) of national natural gene pools. The work done by research organizations and individual breeders in the country on improving economically useful properties of field, row, fruit and berry crops, as well as wild relatives and ancient varieties, will allow legislative securing of innovators' rights to these achievements along with all consequent ethical and material benefits. Enactment of a package of national legislative acts on farmers' rights will encourage the development of draft legislative acts responsive to today's reality and the achievement of national legislation compliant with international documents regulating access to genetic resources and benefit sharing. This will

provide farmers from *daykhan* associations with the opportunity to possess the right to participate in agrobiodiversity conservation *in situ* using their traditional knowledge. As a result, all these activities will provide farmers with the right to intellectual property, i.e., a variety they have bred based on a wild relative or an ancient variety as a part of their traditional knowledge and above all – part of the national wealth of Turkmen culture. At that point, a farmer will become a major driver in implementing food programmes based on traditional varieties of food crops and their wild relatives.

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LEGAL ASPECTS OF SPECIALLY PROTECTED NATURAL AREAS DEVELOPMENT AND *IN SITU* CONSERVATION OF FRUIT CROPS' WILD RELATIVES

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The Kyrgyz Republic is a mountainous country located in the center of the Eurasian continent on the high-mountain massif of the Tien Shan and the Pamir-Alay. The total area is 199,900 sq. km (5.3% forest, 4.4% water, 53.9% agricultural lands and 36.4% other lands). About 90% of the territory is located higher than 1500 m above sea level. The country's extent from the north to the south is 453.9 km (39°15´ – 43°15´ northern latitude), from west to east, 925 km (69°15´ – 80°15´ eastern longitude).

Despite the fact that the Kyrgyz Republic is a small country in terms of occupied territory, it is included in the list of 200 prioritized ecological regions of the planet. This is determined by the highest density of flora and fauna species diversity. Here about 2% of world flora and 3% of world fauna are found, whereas the area of Kyrgyzstan represents only 0.13% of the total world terrain and remoteness from the sea exceeds 3000 km. Kyrgyzstan has relatively small territories (about 20%) with normal bioclimatic condition for livelihood activity where the major part of population is concentrated; almost all industrial and agricultural production is concentrated here and these zones suffer from maximum anthropogenic load, disturbance of the natural balance leading to environmental pollution and depletion of natural resources.

There various natural communities in Kyrgyzstan: fruit and nut, juniper, spruce, deciduous forests, shrubs, tall-grass mid-mountain meadows, mid- and short-grass high-mountain meadows, steppes and deserts, wetlands. Altogether, 22 ecosystems and 160 types of mountainous and plain landscapes can be noted. They are inhabited by more than 50 thousand living organisms. Forest ecosystems are amongst the richest in diversity.

Kyrgyzstan possesses a rich gene pool of varieties representing a potential resource for the creation of highly productive and resistant crops, ornamental plants, and medicinal, aromatic and industrial raw materials.

As a whole, the Republic has favorable natural conditions. However, the gradually increasing process of man's impact on the environment hampers the conservation of numerous plant species. Significant damage to their populations and habitats is made due to reduction of trees and shrubs, ploughing considerable plots of land and drying of ponds.

Included on the list of rare and endangered animal and plant species are 53 bird species, 26 mammal species, two amphibian species, eight reptile species, seven fish species, 18 arthropod species and 89 higher plant species as well as six mushroom species. In 2007 the new edition of the Red List of the Kyrgyz Republic was published; the updated list includes 207 rare and endangered animal and plant species. The last previous update of the list of rare and endangered species was in 1984.

There is no natural ecosystem left in the country that has not been affected by humans. Piedmont flat steppes, riparian forests, wetland complexes in the Chu valley, dry steppe, semi-arid and desert ecosystems in the zone near Fergana have all practically disappeared. Ecosystems downstream of rivers have degraded due to severe pollution and full withdrawal of water for irrigation. Steppe, desert and semi-arid ecosystems of piedmont plains and intermountain valleys, riverine trees and shrubs are all subject to severe pastoral damage. This process has increased near human settlements after transferring livestock into private use.

Continuing desertification and climate change should be noted as natural factors having an impact on agrobiodiversity. Both these factors place biological communities in extreme survival conditions. Existence itself on steep mountainous slopes requires on average 1.5 - 2 times more energy than in similar climatic conditions on the plain. A significant part of the territory is covered with snow almost half the year. The continental character of the climate is expressed by abrupt changes in daily and seasonal temperatures as well as abrupt changes in humidity.

Anthropogenic activity enhances the effect of negative natural factors. Cutting of trees and shrubs, collection of medicinal and esthetically attractive plants, unsystematic grazing and haying are complemented by the indirect impact on the environment by pollution, destruction of habitats during condemnation of land for croplands, roads, human settlements, mining enterprises, reservoirs, etc. As a result of natural habitats being split and reduced in size, species and their reproduction decrease. Many of them are now close to extinction. Processes resulting in the decrease of forest cover are the most serious. It is in the forests where at least half of the species diversity of the country is concentrated.

Analysis of legislation of Kyrgyzstan on specially protected natural areas and biodiversity conservation shows that legislation of the Kyrgyz Republic on specially protected natural areas (hereinafter referred to as SPNA) consists of more than 200 normative legal acts of various levels: from international conventions to local normative legal acts of governmental agencies on environmental protection (orders).

International treaties (treaties, conventions, agreements, declarations, etc.) ratified by the Kyrgyz Republic are of special importance in the legislative system of the country. Their specific character lies in the fact that in case of non-compliance of the laws or another normative legal acts of the Kyrgyz Republic with international treaties it participates in or with generally recognized standards of international law, rules established by these treaties and standards are applied.

The major (most frequent applied) normative legal act in the legislation of the Kyrgyz Republic regarding SPNA is the Law "On specially protected natural areas" that was adopted on 28 May 1994 and regulated relations in the sphere of organization, protection and use of SPNA to conserve reference and unique natural complexes and sites, remarkable natural formations, faunal and floral gene pools, research on natural processes in the biosphere and control of changes in their condition.

Since the adoption of the Law of the Kyrgyz Republic "On specially protected natural areas" in 1994, Kyrgyzstan has acceded to a number of Global Environmental Conventions: "On Protection of the World Cultural and Natural Heritage" (1995), "On Biological Diversity" (1996), "Convention to Combat Desertification" (1995), "On environmental impact assessment in a transboundary context" (2001), "Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters" (Aarhus) (2001), "On wetlands" (Ramsar Convention)» (2002), United Nations Framework Convention on Climate Change (2000), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (2006).

Given the obligations of the Kyrgyz Republic with regard to international conventions, it was necessary to develop a new edition of the Law "On specially protected natural areas." The new Law of the Kyrgyz Republic "On specially protected natural areas" was adopted by the Jogorku Kenesh (Upper Chamber) of the Kyrgyz Republic on 21 April 2011 and signed by the President of the Republic on 4 May 2011. It can be noted that this Law regulates a wide range of legal relations associated with SPNA and biological diversity conservation, including:

- legal status of SPNAs and the procedure for their organization were established;
- natural resource usage procedures in SPNAs were established;
- Standards and requirements of environment protection during economic or another activities were established;
- categories of specially protected natural areas most approximate to the system of categories of the International Union for Conservation of Nature and Natural Resources (IUCN) were arranged;
- standards of ecological tourism development in specially protected areas were included;
- concepts of specially protected natural areas zoning and resulting regimes of the respective zones were established;
- to ensure transparency, accessibility and population awareness, the standards for participation and involvement of local populations, local communities and non-governmental organizations in planning, organizational and operational processes in SPNA were established;

- a new section on transboundary protected natural areas, their regimes and ecological corridors was introduced;
- principles of international cooperation in the sphere of biodiversity conservation and SPNA network development, as well as a number of other issues, were determined.

As opposed to the previous edition of the Law "On specially protected natural areas" of 1994, the edition contains such concepts as: "network of specially protected natural areas", the main objective of development, which is the creation of integral and functionally interrelated combinations of protected natural areas.

The following categories of specially protected natural areas complying with the classification of the International Union for Conservation of Nature and Natural Resources and international standards were determined:

1. State natural reserves;
2. State natural parks;
3. Wildlife preserve;
4. Natural monuments;
5. Botanic gardens, dendrological and zoological parks;
6. Biospheric areas and/or reservations;
7. Transboundary specially protected natural areas.

To ensure a proper protection regime for the specially protected natural areas, primary and preserved (core) zones as well as restricted and buffer zones, will be established.

This Law states that in order to develop scientific and ecological tourism, involve local communities in the processes of organization and sustainable operation of specially protected natural areas, acquaintance with natural and historical and cultural places of interest in the district's specially protected natural areas can be used for tourism development. It is allowed to organize ecological excursion tours, tourist trails and camps, tourist sites, museums and expositions outdoors at the specially dedicated sites depending on the regime functioning in the specified zone according to the procedures established by an authorized governmental agency on environmental protection.

The concept "State cadaster of the specially protected natural areas" was introduced; it includes information on category, purpose, geographic location, boundaries, protection regime, as well as biological, ecological, educational, scientific, economic, historical and cultural value to assess condition of the nature reserve fund, identify the potential for the area's network development, increase the efficiency of the governmental control of adherence to the respective regime as well as registration of these areas during planning of social and economic development of the regions.

This was the first introduction of zoning in the state natural reserves. It was stated that the following zones with various regimes for protection and use had been allocated within the territory of state natural reserves:

1. Core zone;
2. Buffer zone;

3. Restricted zone.

The Law states that the core zone is the territory where the whole natural complex is strongly protected, with monitoring of ecosystem conditions and conducting of research and other activities which do not disturb the natural development of natural resources. Core zones represent at least 75 percent of the state natural reserve's total area. Any economic or other activities disturbing the development of natural processes or the creation of a risk of adverse effect on natural complexes and sites are restricted in the restricted in the core zone.

The regime prevailing in buffer zones of the state natural reserves, which usually surround or border on the core zone and are used for research activities, traditional activities with extensive forms of economic management including regulated use of agricultural lands and conduct of ecotourism, has been specified.

In order to prevent an adverse effect on the condition of biological and landscape diversity in the buffer zone of the state natural reserve, the following activities are prohibited:

1. new settlement establishment;
2. allocation of territories for hunting lands, organization of game husbandries and deployment of hunting seats;
3. construction, deployment and operation of production facilities;
4. prospecting and development of mineral resources;
5. tree felling;
6. introduction (naturalization to new climate conditions) of new plant and animal species;
7. activities changing the hydrological regime of the reserve's core and other activity that can have an adverse effect on the ecosystem as a whole.

It is stated that the restricted area of the state natural reserve is created to reduce the impact on the whole natural complex caused by economic activities of local communities living immediately near its territory.

The main types of economic activities that do not damage the conditions of natural resources are allowed in the restricted zone of the state natural reserve. The following activities are prohibited in the restricted zone of the state natural reserve:

1. gathering of medicinal raw materials, endangered fruits, berries and flowers;
2. hunting, trapping, devastation of nests, burrows and other wild animals' homes as well as gathering of birds' and reptiles' eggs;
3. introduction of new wild animals species;
4. other type of activities resulting in reduction of natural, scientific, cultural and esthetic importance of the state natural reserve.

Special provisions are made for the regime of state natural parks: that a differentiated regime of special protection is established in these territories with accountability for their natural, historical and cultural and other features.

The following zones are defined in state natural parks:

1. Zone of reserve status;

2. Zone of ecological stabilization;
3. Zone of touristic and recreational activity;
4. Zone of limited economic activity.

In reserve status zones of the natural parks, the regime provided for state reserves is established. In the zone of ecological stabilization, the protection regime established is that of prohibiting economic and recreational activity except for regulated ecological tourism and activities on rehabilitation of damaged natural complexes and sites.

In the zone of touristic and recreational activity, the protection regime established is one that ensures the conservation of natural complexes and sites where regulated touristic and recreational use (except for hunting), including organization of tours, tourist trails, bivouac camps and sightseeing platforms with accounting of recreation load standards.

In the zone of limited economic activity, facilities of administrative-economic purpose may be located; economic activity required for ensuring protection and operation of the state natural park, servicing the visitors, including organization of nonprofessional (sports) hunting and fishing may be conducted; construction and operation of recreational centers, hotels, camping sites, museums and other facilities for servicing tourists are allowed.

Any activity that creates risks of adverse effect on natural complexes and sites taken under protection is prohibited in the territory of state natural parks, including:

1. activities leading to changes in hydrological regime;
2. construction and operation of production and other facilities not associated with the operation of state natural parks;
3. development of mineral resources;
4. tree felling;
5. introduction (acclimatization) of new plant and animal species;
6. other types of activities resulting in reduction of natural, scientific, cultural and esthetic importance of the state natural park.

Objectives and regimes are specified for botanic gardens, dendrological and zoological parks that are formed to conserve biodiversity and enrich flora and fauna by the decree of the Kyrgyz Republic on assignment of a specially authorized state agency in the sphere of environment protection and based on the scientific rationale by the Academy of Sciences of the Kyrgyz Republic. Territories of botanic gardens, dendrological and zoological parks are intended for their direct objectives only. For this purpose, plots of land are turned over on a permanent basis to research and educational institutions that manage botanic gardens, dendrological and zoological parks. The main objectives of botanic gardens, dendrological and zoological parks include:

1. conservation under managed conditions of collections of live plants, wild animals (particularly rare and endangered species) of domestic and foreign flora and fauna which have great scientific as well as cultural and educational value;

2. conducting of research activities;
3. conducting of educational and pedagogic as well as research and educational activities in the sphere of plant production, zoology and nature protection.

Any activity not associated with implementation of their objectives and leading to violation of safety of flora and fauna subjects is prohibited in the territory of botanic gardens, dendrological and zoological parks.

The Law of the Kyrgyz Republic "On specially protected natural areas" includes a special chapter on Biosphere territories and reservations which represent areas of ground and water ecosystems or their combinations ensuring a stable balance of biological and landscape diversity, economic development and protection of corresponding cultural values. They are created to:

1. conserve, recover and use natural areas rich in cultural and natural heritage;
2. support long-term and sustainable economic and social development of the region including its recreational utilization with account of natural reserves conservation and recovery;
3. conduct long-term ecological control, monitoring and research activities as well as ecological education and training.

Biosphere territories and reservations are established by governmental decree of the Kyrgyz Republic on assignment of a specially authorized state agency in the sphere of environment protection based on the corresponding scientific rationale and technical design.

There is also a chapter on transboundary and specially protected natural areas of international importance. It states that transboundary and specially protected natural areas of international importance are established based on international treaties of the Kyrgyz Republic that came into effect as required by law. Transboundary and specially protected natural areas of international importance are established to support the overall ecological balance of the biosphere, conservation of biological diversity of flora and fauna species endangered and included in the Red List of the Kyrgyz Republic and neighboring countries, fulfil commitments of the Kyrgyz Republic set by international treaties to which the Kyrgyz Republic is party. Transboundary and specially protected natural areas of international importance are intended for solving the following tasks:

1. implementation of international cooperation in the sphere of protection and use of nature reserve fund areas and sites based on multilateral and bilateral international agreements;
2. development and implementation of international scientific and research programs aimed at nature reserve fund conservation;
3. scientific findings exchange;
4. creation of natural parks and other nature reserve facilities in the neighboring natural reserve territories;
5. organization of cooperative training of research experts;
6. ecological and educational as well as other activities.

The Forestry Code of the Kyrgyz Republic No.66 dated 8 July 1999 regulates the legal framework for protection and use of the Forest Fund, including trees and plants. According to the Code, forests enjoy environment-oriented status and industrial cutting is prohibited in their territories. According to the Forestry Code, state, municipal and private forests are allowed in the country. However, there are at present only state forests. According to Article 11 of the Constitution of the Kyrgyz Republic adopted by the general referendum held on 27 June 2010, "natural resources, water, mineral resources, and forests are the exclusive property of the Kyrgyz Republic" and therefore the above mentioned Forestry Code is subject to revision. In accordance with the Code, lands both covered and not covered with forests but assigned to forestry needs are referred to as lands of the Forest Fund. Agricultural lands of the Forest Fund are used in accordance with the Provision "On procedure of agricultural land use of forest fund of the Kyrgyz Republic" approved by the Decree of the Cabinet of Ministers of the Kyrgyz Republic No.449 dated 12 September 1991.

The Law of the Kyrgyz Republic "On protection and use of flora" regulates relations associated with protection and use of flora. This Law establishes the procedure for plant use (for livestock production and apiculture needs; stocking, gathering, accepting, processing and selling of wild medicinal, industrial and food raw materials, etc.), as well as the procedure for compensation of damage, etc.

According to the standards of the Land Code of the Kyrgyz Republic, land resources are subdivided into the following categories based on their purpose:

- agricultural lands (irrigated arable land, dry arable land, perennial plantings, hayfields, pastures);
- human settlement lands (towns, urban settlements and rural settlements);
- industry, transport, communication, defense and other designation lands;
- specially protected natural areas lands;
- forest lands;
- watershed lands;
- reserve lands.

The above-mentioned agricultural lands, specially protected natural areas lands, forest and water fund lands as well as reserve lands can be efficiently used for the development of farm activities directed toward conservation and breeding of endemics – wild relatives and cultivated pomaceous and stone fruit crops.

Today a certain attention is paid by public authorities to the sector of SPNA and biodiversity conservation. Effective laws of the Kyrgyz Republic "On environment protection", "On specially protected natural areas" and "On biosphere territories in the Kyrgyz Republic," as well as resulting subordinate normative legal acts, regulate relations in this sphere, establish the basis for conservation and recovery of the most important floral and faunal types of complexes, ecosystems and landscapes. They also govern sustainable reproduction, maintenance and rehabilitation of viable species populations in their natural environment (*in-situ*) and conservation of biological diversity components outside their natural environment (*ex-situ*) and determine parameters for SPNA expansion. They are

aimed at establishing an economic mechanism facilitating biological diversity conservation and rational use.

The State Agency on Environmental Control and Forestry under the Government of the Kyrgyz Republic (State Agency) has developed a new "Strategy of biodiversity conservation" and "Action plan on biodiversity conservation for 2011-2015". In order to cover the diversity of fruit crops wild relatives, this plan includes activities on the creation of state natural reserves and state natural national parks (SNNP). State natural reserve "Sarkent" and SNNP "Surmatash" were established in 2009 and 2010, respectively. The provisional government of the Kyrgyz Republic adopted a decree on approving establishment of state natural reserve "Dashman" and SNNP "Avletim".

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LEGAL ASPECTS OF PEASANT (FARM) ENTERPRISES DEVELOPMENT IN THE KYRGYZ REPUBLIC

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This paper provides a brief analysis of the conditions (climatic, socio-political) of the existing legal framework of the Kyrgyz Republic and actions taken by the government to develop peasant (farm) enterprises and to widely introduce market relations in the agricultural sector. It also provides a brief analysis of legislative acts of the Kyrgyz Republic regulating relations in the sphere of farm enterprises development as well as legislative acts regulating relations in the sphere of breeding achievements and traditional knowledge protection.

During the past 15-20 years in the Kyrgyz Republic (hereinafter referred to as KR), significant progress was achieved in conducting agrarian and land reform and a specific legal framework was established to develop private farm enterprises on private lands.

The land that had been previously used for collective management was made available by the government for free use by the rural community for a period of 99 years; later, during the land reform development process, amendments and additions were approved and as a result arable lands were gradually turned over without compensation to private ownership according to the established principles. More than 286,000 peasant (farm) enterprises and about 700 various associations, including 452 cooperatives, have been created.

Today, despite a number of problems, Kyrgyzstan provides itself with the primary types of agricultural products, including meat, milk, vegetables and to some extent grain. As a whole, Kyrgyz Republic does not produce its own essential products such as sugar and vegetable oil.

The Kyrgyz government supports farmers to the extent possible through allocation of seed, material and equipment, commodity loans and grants. The

Republican budget provides for annual funds for renovation and rehabilitation of waterworks facilities, protection and quarantine of plants and improvement of the epizootological environment.

The analysis of the Kyrgyz Republic's legislation on the issues of farm enterprise development demonstrates the following:

- The Law of the Kyrgyz Republic "On peasant (farm) enterprise" No.47 dated 3 June 1999 regulates the main issues of establishing and operating farm enterprises (hereinafter referred to as FE).
- A set of people having the right to establish farm enterprises has been assigned, with the mandatory requirements to establish a farm enterprise as an independent legal entity, its supreme management body (general meeting of farm enterprise members), the terms of reference of the farm head, rights and obligations of the farm members as well as a number of other issues.
- The Land Code of the Kyrgyz Republic No.45 dated 2 June 1999 regulates land relations, grounds for acquiring the right to use the land, procedure for the exercise and termination of rights and is aimed at the creation of land and market relations under state, municipal and private ownership of land as well as its rational use and protection.
- The Law of the Kyrgyz Republic "On regulation of agricultural lands" No.4 dated 11 January 2001 regulates legal relations of agricultural land management and is aimed at ensuring efficient and safe land use for the benefit of the people of Kyrgyzstan.
- The legislation of the Kyrgyz Republic in the sphere of farmers' rights encompasses a wide range of normative legal acts of various levels.
- The Constitution and the Civil Code of the Kyrgyz Republic regulate the issues of private property protection, including products made by agriculture.

According to Article 49 of the Land Code of the Kyrgyz Republic, a land plot owner and a land user have the right to:

- independently manage the land, using it in accordance with its designation;
- suppress any attempts to infringe the rights for the land plot and intrude onto the land plot against the will of the owner;
- own the crops and plantings of agricultural plantations, harvested crops from the land plot as well as income from selling them;
- in due course, use small deposits of common mineral resources exposed on the surface as well as forest lands and bodies of water located on the land plot as well as utilize other useful properties of the land;
- receive compensation for damages in cases stipulated by the law of the Kyrgyz Republic;
- construct buildings and structures according to established procedure;
- perform other acts stipulated by land laws.

The legal framework of Kyrgyz Republic is thus aimed at large-scale introduction of market relations to the agricultural production system and guarantees all farmers equal rights to land access and use, access to genetic resources, conservation and exchange of reproductive material, benefits from

genetic resources use, freedom to choose crops or varieties to cultivate, and disposal of results of their work.

Small farmers cultivating fruit crops have access mainly to those fruit crops existing in the market and to wide-spread varieties and species. During past years, the large-scale introduction and selling of improved varieties in home markets has not been observed and participation in international trade exhibitions of elite varieties is a rather costly affair. Moreover, many farmers prefer to cultivate on their relatively small plots annual crops for the production of staple products that produce yields in the year in which they were established, such as grains, legumes, solanaceous crops, etc. Considering that fruit crops are not essential food stuffs and have a prolonged term of bearing (producing only in the fourth or fifth years), they are cultivated mainly in courtyards and farmlands and not on land plots.

The farmers' right to governmental financial and technical support arises in *force-majeure* circumstances (droughts, floods, fires, etc.) and in all instances of production when a farmer expresses a desire to cultivate on his/her land plots the seeds proposed by the government at a reduced price.

The farmers' right to assist and participate in the decision-making process is exercised through local and national representative bodies (local *keneshs*, *Jogorku Kenesh*), associations and unions. However, this right is exercised fragmentarily and occasionally.

The farmers' rights to the intellectual property of the crop varieties they have bred and used is protected the Law of Kyrgyz Republic "On legal protection of breeding achievements" No.79 dated 13 June 1979. There is no doubt that this Law of the Kyrgyz Republic is aimed at the protection of intellectual property primarily of breeders, but in cases when genetic resources conserved by farmers were used, their participation in cooperation with breeders is possible.

In cases of traditional knowledge use by breeders and farmers, the right to registration and to their traditional knowledge is regulated by the Law of the Kyrgyz Republic "On protection of traditional knowledge" No.116 dated 31 July 2007, which stipulates that traditional knowledge includes not only knowledge, but also techniques and methods, including use of genetic resources applied in various spheres of human activity, and which have been transferred from one generation to another in a certain order and sense.

Today, the government of Kyrgyz Republic takes a number of measures to develop agriculture and ensure food security. Thus, the decree of the government of Kyrgyz Republic No.116 dated 11 February 2009 approved the Action Plan which stipulates the system of governmental support to agriculture:

- procurement of agricultural equipment out of the grant funds from donors;
- development of rural consulting services on agricultural technology, marketing, etc. through establishment of respective centers;
- support to the financial status of rural commodity producers through writing off bad debts on budgetary loan and foreign credits for the period of 1992-2007;
- introduction of subsidized expenses of seed-producing enterprises that produce and sell super-elite and elite seeds;

- expansion of crop cultivation areas up to 1,165,000 ha, increasing the volume of sown wheat to 420 thousand ha and a number of other activities.

We hope that integrated actions taken by the Kyrgyz Republic government and aimed at agricultural sector development based on learning best international practices will allow ensuring food security in the Republic. It is obvious that to efficiently introduce the principles of *in situ*/on farm conservation and distribution of fruit crops and their wild relatives, advantages which farmers may obtain through growing and breeding fruit crop wild relatives must be widely promoted.

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ROLE OF LOCAL COMMUNITIES IN LOCAL AGROBIODIVERSITY MAINTENANCE AND TRADITIONAL KNOWLEDGE MANAGEMENT THROUGH THE EXAMPLE OF UZBEKISTAN

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As a result of reforms conducted in Uzbekistan in the sphere of agrarian and ecological agrobiodiversity, the importance and role of agrobiodiversity are growing more and more significant. The Resolution of the President of the Republic of Uzbekistan (RUz) No. PP-255 of January 2006 “On organizational measures on reforming fruits and vegetables production and viticulture” has become one of the principal documents in the reforms carried out on expansion and development of fruit and vegetable production in Uzbek agriculture Under this resolution, specialized farm enterprises were established on the basis of 219 *shirkat* enterprises and 320,424 ha of lands were allocated to them. Established branch enterprises specialize primarily on fruit and vegetable production and viticulture.

To ensure efficient rendering of services to organizations in agrarian sector during recent years, the following were established: 975 mini-banks, 1534 independent machine and tractor forces, 1301 water user associations, 882 mineral fertilizer delivery points, 1117 oil product delivery points, 494 agricultural product delivery points, 337 livestock product sale and zooveterinary services delivery points, 270 information and consulting services delivery points, 68 transport services delivery points, 72 containers, dishes and packaging material supply delivery points and 195 farm firms. Today, they primarily facilitate production and processing the products of fruit and vegetable production and viticulture, provide information and assistance in new innovation projects.

Today, the Government provides a number of benefits for private household plots, *dekhkan* and farm enterprises with operations related to the output of horticulture, vegetable and viticulture products.

During recent years there has been an increase in population growth, worldwide climate change and growth of requirements in fruit and vegetable products. Certain positive activities have been carried out during the years of independence to fully supply the population with food stuffs, satisfy the home consumer market and increase the outputs from agricultural production. If in 1990, according to mean values, fruit production made up 34.5 kg per capita on the average, then in 2010 these values per capita accounted for 61.1 kg—i.e.,

there has been growth of 177% as compared to 1990. If in 1990 the Republic's population was supplied with fruit and vegetable products on the order of 57% of the total, then by 2010 the value was 108%.

During the past five years, fruit and vegetable product output has increased 1,7 times and in 2010 reached 11,919,500 tons. 1,271,100 tons or 13% of the output were processed, including 19% of fruit crops and 25% of grape. Product processing in farm firms and by entrepreneurs of 186 mini-technology processors of fruit and vegetable products reached 1,271,100 t in 2010, which showed a 4.6-fold increase as compared to 2005 owing to the establishment of processing facilities in farm enterprises.

In order to increase the supply of quality fruit and vegetable and viticulture products, activities on horticulture and viticulture development were designed in mountainous and piedmont districts of the Republic and these were approved by a special protocol of the Cabinet of Ministers of the Republic of Uzbekistan. According to this protocol, agricultural organizations and institutions, nature protection agencies, local *khokimiyats*, nongovernmental nonprofit organizations and autonomous bodies have developed a number of practical programmes. In particular, every organization based on historical and local traditions pays attention to the establishment of small gardens, the creation of intensive gardens, increasing local seedlings in piedmont and dry districts as well as the development of a national gardening culture.

In 2010, given the limitation of irrigated lands and in order to supply ecologically clean and high-quality products of fruits and vegetables, new orchards on 14,600 ha and vineyards on 5,300 ha were established including 2,400 ha of dwarf and semi-dwarf (intensive) orchards, 12,300 ha of orchards and 5,400 ha of vineyards were rehabilitated. Two hundred seven million fruit trees and grapevines were planted in the country under the slogan "Twenty seedlings are my gift," coinciding with the 20th anniversary of independence of Uzbekistan.

The carrying out of agronomic activities, ploughing of inter-row spacings, watering, pest control, and timely fertilizer application contribute to a high yield of fruit and vegetable crops. In 2011, practical work on fruit and vegetable productivity improvement resulted in an increase of 30-40%. It is expected that a total of 17,301,000 t (an increase of 145% as compared to 2010) of fruits and vegetables will be produced and delivered in 2011. Of this number, 2,149,700 t are fruit products (126% more as compared to 2010) and 1,293,200 t are grape products (131% more as compared to 2010). By the end of 2011 it is expected that approximately 17,301,800 t of fruit and vegetable crops and grapes will be harvested in farm enterprises along with farmlands and summer cottage plots of population (49% in farm enterprises and 51% on farmlands and summer cottage plots).

Lands under orchards is in total 236,000 ha (or 8,600 ha or 104% more as compared to 2010). Of this number:

- 184,500 ha are with high-yielding fruit orchards (or 4,300 ha or 103% more as compared to 2010 more than the previous year);
- 133,000 ha are with vineyards (or 2,000 ha or 102% more as compared to 2010 more than the previous year).

Newly Established:

- a total of 13,500 ha (11,200 ha more as compared to 2010);
- new vineyards – 5,300 ha (4,000 ha more as compared to 2010);
- intensive orchards – 2,100 ha;
- rehabilitated orchards – 11,800 ha (or 1,600 ha less as compared to 2010);
- rehabilitated vineyards 5,200 ha (800 ha more as compared to 2010).

Ancient horticultural varieties recover as a result of governmental policy on enhancing the role of community at the local level in managing traditional knowledge on agrobiodiversity maintenance as well as through the process of implementation of international donor organization projects. Expansion of experimental lands as a basis for horticulture development contributed to horticulture and viniculture production growth in all regions of the country and has a positive effect on agrobiodiversity development and environmental protection.

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TRADITIONAL AND MODERN METHODS FOR APRICOT FRUITS PROCESSING USED IN FARM ENTERPRISES IN TAJIKISTAN

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The issue of fruit product processing at the current level of horticulture development is very urgent for all Central-Asian countries. Central Asian countries have exceptionally favorable natural and environmental conditions for dried product output and other types of raw materials processing, as the quality of their dried fruit varieties of apricot, plum, peach, unabi and fig are without parallel. However, these opportunities are still not fully utilized.

In Tajikistan apricot drying is relatively widespread. The Sughd Region of Tajikistan is one of the main regions for the production of such types of dried apricot as uryuk, kaysa, kuraga and ashtak. It produces more than 80% of the total output in the Republic. Fruit drying is the most ancient and important sector of the food and pharmaceutical processing industries and is still topical nowadays. A huge amount of various fruits is preserved using exactly this method. Dried fruits are traditional semi-finished products for compote and seasonings during winter time.

Dried fruit production is the most efficient method of fruit raw material processing that allows prolonging the period of fruit storage, consumption and supply for populations in remote regions at relatively low cost. Fruit mass reduction during dehydration by 75-80% significantly cuts down the cost of dried fruit transportation over long distances. Dried fruits contain easy-to-handle sugars, acids, vitamins and other valuable substances essential for normal human life and activities. According to physiological standards, the daily ration must include no less than eight g of fruits and vegetables.

The natural and climatic condition of the Republic of Tajikistan, the centuries-old experience of local population and, above all, the occurrence of unique fruit varieties suitable for drying allow the Republic to function as a major base for both fresh and dried fruit production. However, during recent years the range of dried fruits has significantly worsened along with the decrease in the rate of production growth. The share of kaysa, apricot kuraga, uryuk, etc. is reducing.

Raw material resources for dried fruit production in the Republic are used irrationally and for purposes other than that intended. Under rational use of these resources the current level of production can be increased 2-2.5 times. Huge reserves are located in Sogd Region, where more than 90% of apricot

plantations in the Republic are located. High-quality apricot varieties (Kandak, Kadu-Khurmoi, Mirsandjali, Isfarak, Subkhoni, Boboi, Todjiboi, Niyozi, etc.) are used for production of world's best dried fruits varieties – kaysa, kuraga, uryuk.

Further development of dried fruit production depends not only on raw material capacity but also on production and technical facilities of primary fruit processing – drying, sorting, peeling. Drying of products in farm enterprises is the most labor intensive process. It takes from four to six weeks, which does not allow drying the required volume in the tight drying season.

Drying in farm enterprises is primarily done using traditional methods, i.e. solar drying in open areas. The whole process is done manually with no mechanization. Primary processing production and expansion and enhancement of technical facilities is becoming rather frequent. In future, fruit drying must be shifted to assembly line on a mechanized basis with large-scale introduction of progressive processing equipment. Intensification of fruit drying processes can be conducted through various methods:

- improving the design and increasing the performance of dryers of various types;
- applying machine methods of preliminary processing of raw materials;
- treatment of fruits with chemical agents of various origins with further use of appropriate types of dryers;
- use of biochemical agents for raw material treatment primarily through application of enzymatic agents.

In particular, dryers require more fuel and their capacity for increase in performance is rather limited. Application of air natural solar drying as well as heliodryers is economically the most sound. Machine methods of intensification primarily consist of preliminary processing of fruits by stabbing, incision or mechanical deformation. Widely applied preliminary treatment of raw materials with acid and alkaline solutions must be noted among the chemical methods of intensification. Application of biochemical methods is fairly new and a promising way of intensifying the drying process. The principle of the method is simple – microincisions are made to walls of plant cells, which accelerates the elimination of moisture. This is achieved by application of enzymatic agents that have an effect on the biopolymers of cell walls. Today, highly efficient enzymatic compositions are created that are able to persistently modify fruit surfaces and significantly accelerate the drying process. Preliminary treatment with enzymatic compositions allows reducing the period of solar drying 2.5-fold, heliodrying 1.8-fold, and chamber drying 1.63-fold. Expenditure of thermal energy for various types of raw materials is reduced from 1.5 to 4.0-fold.

Air and solar fruits drying. In Tajikistan air and solar fruit drying is widely spread due to conditions of long hot summers and warm autumns. This is the easiest and most affordable way to preserve food during the period of mass ripening without additional expenditure of power fuel. This method is traditionally used for drying apricots, peaches, plums, apples, pears. fig, cherry and unabi.

Dried fruit contains 52-90% sugar, including 6-40% glucose, 10-46% fructose, 4-42% sucrose, 1-7% organic acids, 5-44 mg/% vitamin C, up to 3.5

mg/% provitamin A (carotin), 248-3512 mg/% of vitamin P (rutin) and 4.6-6% pectin. In addition, they contain mineral salts, proteins and a number of other substances vital for the human organism.

The content of nutrients in the finished dried product depends largely on the drying technology. Application of advanced air and solar drying allows the production of high-quality dried fruits with a high content of biologically active substances and a maximum output in the form of finished product.

*Organization of drying station***.** The drying area should be well illuminated and ventilated, provided with water and equipped with fumigation cases or chambers, scalding pots, ovens, trays, baskets for scalding. The size of the site must match the volume of raw materials. The average area of the drying areas shall comply with the estimated need for 1m² for every 10-12 kg of apricots and peaches with stones, 6-8 kg of apricots and peaches cut into halves, 14-16 kg of plums and pears as whole fruits and 10-12 kg of them cut into halves, and 3 -5 kg of apples sliced in circles.

*The organization of product gathering, delivery and preparation for drying***.** Fruits delivered for drying should be at the level of harvest maturity with fruit sugar content of 16-25%. Fruits delivered for drying must be clean, not damaged, of pure color. To ensure this, the fruit must first be sorted and washed.

Depending on the type of raw material, blanching is conducted before drying. This type of treatment is used for plums to remove the wax coating from the surface and to form small cracks on the surface, through which the moisture evaporates more rapidly. Blanching of peaches is conducted to remove the peel. Fruits are dipped for 3-5 seconds into a boiling solution of caustic soda.

Concentration of the solution used for fruits is 0.5%. Fumigation with sulfur dioxide (sulfitation) is carried out to suppress the activity of microorganisms that cause spoiling of fruits. After fumigation the fruits retain their bright colors, have a nice appearance, and can be stored for a long period. Sugars, organic acids, and vitamins are preserved better in the dried products. Fumigation is performed in special chambers or under fumigation cabinets. Sulfur consumption for fruits - from 100 to 200 g per 100 kg of raw material, the duration of fumigation - 0.5-2 h. Residual content of sulfur dioxide in the finished product must not exceed 0.01%. Scientists have developed a new method of sulfitation – treatment of fresh fruits in an aqueous solution of sulfur dioxide of 3.5% concentration for three minutes. In comparison with fumigation this method of wet sulfitation reduces the duration of the process, creates the conditions for the flow of production with machine drying and reduces the residual sulfur content in the finished product

Apricots drying. Central Asian varieties are the best for drying: Mirsandjali, Boboi, Kandak, Khurmoi, Kadu Khurmoi, Isfarak, Tadjiboi, Niyozi, etc. Depending on the method of fresh fruit preliminary preparation and processing of dried apricots are divided into the following types:

- Uryuk (fruits dried wholly with stones and usually, but not always, fumigated with sulfur dioxide);
- Kaysa (fruits fumigated with sulfur dioxide and dried whole but without stones - they are removed by extrusion through the place of attachment of the fruit stalk)

- Kuraga (dried apricots without stones and halved).

*Peaches drying***.** The following are the best varieties for drying: Elberta, Lola, Obilniy, Farkhod, etc. They can be either fumigated or non-fumigated. To produce high-quality dried fruit, the peel is removed, but only from lowered and fully ripe fruits.

Sorted fruits are immersed in a boiling alkaline solution for about 30-90 seconds, depending on the variety. After scalding, the basket is immersed in clean cold water, where the fruits are washed and cooled. The peel is easily removed from the fruit treated this way. Peeled fruits are cut into halves, the stones are removed, fruits are put on trays and fumigated with 1-1.5 g of sulfur per one kg of raw material. Depending on the size of the fruits, the drying process lasts 7-22 days.

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STRENGTHENING INSTITUTIONAL RELATION IN THE CONSERVATION OF FRUIT CROP BIODIVERSITY

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Biodiversity of fruit crops and wild species is one of the natural resources of Kyrgyzstan. Due to the geographical features of the country there is a large deversity of fruit crop varieties and their wild relatives. Various institutions such as government agencies, research, educational institutions, farmers, farmers' associations, local communities and NGOs working in the field of agricultural development play an important role in the conservation and sustainable management of fruit crops and wild species.

Many partner organizations, including biological institutes of the National Academy of Sciences of the Kyrgyz Republic, the K.I. Skryabin Kyrgyz National Agrarian University (KNAU), the Kyrgyz Research Institute of Agriculture, representatives of the State Agency on Environmental Control and Forestry and the Ministry of Agriculture, have been involved in project implementation in Kyrgyzstan.

In 2007-2008 partner organizations signed a cooperation agreement. According to the agreement, signatories committed themselves to cooperate in identifying, planning and execution of actions needed to achieve project outcomes. The agreement was signed by nine partner institutions: the E.A. Gareev Botanical Garden of National Academy of Science of the Kyrgyz Republic, the Research Institute of Agriculture, the State Agency on Environmental Control and Forestry, the Ministry of Agriculture, the Prof. P.A. Gan Forest Institute of National Academy of Sciences of the Kyrgyz Republic, the K.I. Skryabin Kyrgyz National Agrarian University (KNAU), the Institute of Nut and Fruit Crops of the South Branch of the National Academy of Sciences of the Kyrgyz Republic, the Innovation Center of Phytotechnology of the National Academy of Sciences of the Kyrgyz Republic

and the State Commission on Agricultural Crop Variety Control under the Ministry of Agriculture.

Project partner scientific organizations were provided with computer equipment, fax machines and telephones; electronic communication for a broader exchange of information between researchers and other stakeholders was established. Representatives of partner organizations participated in all project events, which provided them with the opportunity to work together as a team during implementation of the project.

Existing links among farmers, among institutions, between institutions and farmers and local communities were analyzed during the project. The analysis showed that currently farmers and local populations have connections with a limited number of local organizations. These are mainly procurement and processing enterprises to which the local population sells their crops. In rural areas where the scientific and production organizations are located, local residents have the opportunity for cooperation, but these contacts are limited to receiving advisory services. Contacts between the farmers are limited to a circle of relatives or contacts who have knowledge and experience in the field of horticulture. In the villages there are no non-governmental organizations and associations that can provide assistance to the development of rural resources.

Studies carried out in organizations showed that the relationships between research organizations that collect and manage information on fruit crops varieties as well as breed new varieties and forms of crops are rather weak.

Despite the fact that most of the research institutes are involved in various projects and programs, there are still no sufficient contacts for cooperation and information sharing between these institutions. Insufficient funding of research institutions, outdated scientific base and low staff motivation are the limiting factors in establishing stable cooperation. Successful implementation of the project depends on the establishment and strengthening of linkages between these institutions.

Activities under the project's component on broad participation and partnership included the creation of local committees on management, evaluation and establishment of linkages between groups of stakeholders, involving farmers and maintaining communication at the working level.

Seven multifunctional local committees (MLC) were established at the project sites to provide efficient coordination of project activities, strengthening the link between major groups of partners at the site level: three in Karalma, Jalgyz Jangak and Toskool-Ata villages in Jalalabad Region, two in Baktuu-Dolonotuu village in Issyk-Kul Region, one in Tosh-Bulak village in Naryn Region, one in Petrovka village in Chu Region.

The committees comprised representatives of local government and academic institutions as well as farmers and local communities. MLC members provide all-round support to the project implementing units in carrying out field surveys, establishing demonstration sites, selecting the nurseries, conducting workshops and round tables, coordinating project activities at the local level through recommendations and involvement of experienced and knowledgeable farmers in the project. To ensure farmers' access to collected information and databases

created on local fruit crops varieties, local multifunctional committees were provided with computer equipment.

Two local Coordination Committees (LCC) were created in Jalal-Abad and Issyk-Kul Regions. These Committees link Multifunctional Local Committees to each other, ensuring distribution of the lessons learned and knowledge sharing between project sites and implementing units. Two meetings were held in each LCC where fulfillment of a plan to facilitate the implementation of activities was discussed.

Two international conferences were held on (1) research practices in the area of problems in the conservation of fruit crops, forests and wild relative biodiversity and forest ecosystem monitoring were dedicated to the tenth anniversary of the Department of Forestry of K.I. Skryabin Kyrgyz Agrarian University (16 October 2009) and (2) the conservation and sustainable use of the biodiversity of fruit crops and their wild relatives (17 June 2011).

The project participants took part in a fair of agrobiodiversity products in Jalal-Abad, organized by the Bioversity International-led project: "The revival of biocultural heritage: Strengthening the socio-economic and cultural foundations of agrobiodiversity management to promote development in Tajikistan and Kyrgyzstan" (15-16 August 2008). At the exhibition nut and fruit products were presented (walnut, pistachio, fruits of Niedzwetzky apple) and participants were given leaflets and posters with information about the activities of the project.

To facilitate the involvement of farmers, information leaflets about the farmers who grow local varieties, databases have been developed on farmers' achievements in the *in situ*/on farm conservation of local varieties of fruit crops and their wild relatives. To promote the activities of farmers cultivating fruit crops, two exhibitions of planting material of local fruit crop varieties were held, highlighting farmers' achievements, the establishing of partnerships between stakeholders as well as the demonstration of planting material of local fruit crop varieties.

The first exhibition was held in the south of the Republic in Jalal-Abad, on 12 March 2011 on the square near the Barpy Theater. The exhibition presented seedlings of apple local varieties (Rennet Simirenko, Aport, Kandil Sinap, Korei) and seedlings of wild forms of apple and walnut. The exhibition was attended by: the head of the Territorial Administration on Environmental Control and Forest Ecosystems of the State Agency of Environmental Control and Forestry, the head of the Regional Phytosanitary Quarantine Service, the Director of Toskoolata Forestry Enterprise, an expert from the Rural Advisory Services, nurserymen, farmers and local residents of project sites. Representatives from the regional newspaper "Akyikat" and regional television channel "ZHTR" attended the exhibition to give coverage to it. Information about the show was broadcast on a regional television news program on 13 March 2011.

The second exhibition was held on 10 April 2011 in the village Bosteri in Issyk-Kul Region, where planting material of 12 local varieties of apple and currants grown in project nurseries in Issyk-Kul and Ton districts was introduced. The exhibition was attended by representatives of local government (Semenovsky and Bosterinsky *aiyl okmotu*), the director of the Issyk-Kul fruit and berry site,

nurserymen, involved farmers and local residents of the project sites. During the exhibition farmers and residents of eight nearby villages were given 550 seedlings of local apple varieties free of charge.

To hold exhibitions of local fruit crop varieties planting material, the project team prepared booklets on nurseries and demonstration plots, an advertising banner, newsletters about local varieties of apple trees and information leaflets about the farmers who grow local varieties. During the exhibition participants and stakeholders were handed leaflets, information sheets on local apple varieties, brochures, posters and calendars.

In order to facilitate the distribution of experience and knowledge among farmers and scientists, two seminars on experience sharing were held. The seminars were organized in the demonstration farmers' orchards. During the workshop farmers discussed the main agrotechnical practices applied in orchards and became acquainted with the most important economically valuable traits of local varieties of apple, currant and wild species of walnut and pistachio (yield, fruit quality, storability/processability of fruits), etc.

To facilitate the creation of associations of farmers who grow local varieties of fruit crops and their wild forms, advisory assistance was provided during the development of the statute, as well as informational meetings and preparation of documents for the registration of the "Association of Gardeners". The public association was officially registered. The founders of the public association "Association of Gardeners" are farmers from Ak-bulak village in Issyk-Kul Region.

Computer equipment was handed over to the public association "Association of Gardeners".

Strengthening links between researchers and farmers will help to further the conservation and sustainable use of globally important fruit crop varieties and their wild relatives.

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TRADITIONAL KNOWLEDGE AND PLANT GENETIC RESOURCES LEGAL PROTECTION

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Today, state-of-the art technologies (*biotechnology, genetic engineering, biochemistry, pharmacology, etc.*) are developing very rapidly. Awareness of the importance of using environmentally friendly traditional technologies, knowledge and methods of use of natural resources, including plant genetic resources, and environmentally-friendly raw materials has been increasing.

Increasingly frequently, society turns to the traditional (*folk*) medicine, secrets and techniques that have been kept since ancient times. Increasingly frequently and at all levels of society, issues are being raised regarding the need to introduce environmentally sound agriculture, the use of products produced without the use of chemicals and genetic engineering and foodstuffs grown and produced through conventional methods using plant genetic resources. In this connection, the issues involved regard access to environmentally sound agricultural products and techniques, the distribution of profits from these products, and their full legal protection.

Genetic resources found in the environment (*in-situ*), as well as traditional knowledge associated with these resources, are the unique property of certain regions and are national patrimony; their use is often associated with age-old traditions and people's traditional nature management.

The conservation and maintenance of genetic resources outside the natural environment (*ex-situ*) is carried out in genebanks, storage facilities and other collections. The research organizations associated with these facilities are

currently experiencing financial difficulties, and with great difficulty, and mainly due to the enthusiasm and dedication of scientists, preserve the national patrimony - national plant genetic resources.

Such organizations can provide genetic material for scientific, research and other purposes to other scientific and commercial organizations, both domestic and foreign. On the basis of the transferred material, intellectual property assets are created. Subsequent use of these assets brings profit, although the custodians of genetic resources themselves usually do not benefit from finished products. On the one hand, plant genetic resources and traditional knowledge become objects of scientific and commercial interest and then a wider public requires access to them. On the other hand, the traditional knowledge owners themselves, as well as the custodians of the plant genetic resources in question do not benefit from the profits deriving from the use of these assets.

What do we mean by traditional knowledge? Traditional knowledge is not limited to any particular area of technology or science. The whole range of human activities is open to traditional methods of research and all kinds of human self-expression are suitable for their transfer. The use of existing traditional knowledge in medicine, veterinary science, agriculture, food industry, breeding and ecology is a generally known fact. Other aspects of traditional knowledge include music, dance, language, crafts, symbols, undisclosed information, as well as moral and ethical values, social institutions, ritual conceptions, and religion. Plants and animals used in medicine and agriculture are also frequently symbols of the value for a particular nation or community, and many works of handcraft art are created according to strict ritual customs due to their symbolic or religious significance (Ponomareva 2011).

Such a wide range of objects considered and described as “traditional knowledge” can be divided into three parts: genetic resources, traditional knowledge and folklore. These three components are indissolubly connected, intertwined and accompany each other. The reason for discussing such seemingly diverse themes as plant genetic resources and traditional knowledge at the same time lies in the fact that they are interrelated and have common characteristics.

First, they represent a common national heritage and the patrimony of particular countries and regions. The term “heritage” includes all kinds of literary and artistic works such as music, dance, song, prose and poetry as well as all kinds of scientific, agricultural, technical and ecological knowledge, including medicine and the rational use of flora and fauna”.

Plant genetic resources were anciently used in combination with traditional ecological knowledge to create animal breeds and plant varieties, which, as the result of traditional knowledge, are themselves, in the judgment of scientists, one of the elements of universal culture and national cultural heritage.

The second common characteristic of plant genetic resources and traditional knowledge is that they comprise an asset which is transformed and developed beyond the logic of individualized human intellectual activity. Plant genetic resources complicate the boundaries of human innovation because they self-reproduce, being living resources. Traditions that form the basis of traditional knowledge and folklore are developed by individuals and across generations.

In both cases human creative activity creates a significant value. However, sometimes these objects transform themselves according to the logic which is beyond individualized creativity and independent of it. They are associated with collective creativity and often individuals cannot acquire intellectual property rights.

The primary objective with respect to common heritage is its conservation so that other creators and innovators can be free to use the elements of this heritage, creating something new that is an intellectual property asset.

The role of intellectual property is very significant in conservation, management and use of genetic resources and traditional knowledge and in the distribution of profits derived from their use. For example, intellectual property rights are granted for the use of genetic resources of plants, animals and microorganisms, knowledge of which contributes to traditional knowledge in medicine, agriculture and ecology. Traditional knowledge in a number of crafts, arts and music are used in the entertainment and fashion industries to create works that are protected by intellectual property rights (Blakeney 2001).

Plant genetic resources and traditional knowledge are not the same in all regions and provide an advantage to those regions that are rich in biodiversity and that may allow them to enter the market more efficiently. Accordingly, protection of plant genetic resources and traditional knowledge can be considered a potential tool for the integration of least developed regions in the economy.

In this regard, it is important to address the implementation of a major international agreement, the Convention on Biological Diversity (Rio de Janeiro, 1992), which may have an impact on how traditional knowledge associated with genetic resources use shall be subject to protection and distribution. The Convention, which has recognized the importance of preserving traditional ecological knowledge and the biological diversity of nations, has become an essential step in this direction.

Traditional knowledge includes scientific, literary and artistic works, performing of works, inventions, scientific discoveries, designs, drawings, signs, names, symbols, undisclosed information, moral and ethical values, social institutions, ritual conceptions and other assets in the field of science, technology and culture based on historical experience and traditions handed down from generation to generation.

There are various definitions of genetic resources. One of the most common is the one provided in the Convention. However, this definition makes no mention of such an important element of this concept as “biological material,” which is important in the treaty practice of transfer of germplasm. Based on the definition in the Convention, scientists proposed the following definition of the “genetic resources” concept: “Genetic resources are genetic material of actual or potential value for mankind and implies any biological material of plant, animal, microbial or other origin containing functional units of heredity.”

Management of access and transfer of plant genetic resources and associated traditional knowledge must be based on properly formulated contract terms (Saint-Petersburg 2005, Ponomareva 2003). For this purpose, during the preparation of a contract on access to and transfer of plant genetic resources and associated

traditional knowledge, the following elements reflecting their specifics are recommended to for inclusion in the contract:

- terms and definitions related to plant genetic resources and traditional knowledge;
- the origin of plant genetic resources and associated traditional knowledge;
- indication of intellectual property assets related to plant genetic resources and traditional knowledge and created before the conclusion of the contract;
- privacy;
- rights and obligations of the party providing plant genetic resources related to intellectual property;
- rights and obligations of the party receiving plant genetic resources related to intellectual property;
- obligations related to resources rational use of plant genetic resources and environmental measures;
- notification to plant genetic resources and traditional knowledge owners and keepers and their prior consent for access to these assets;
- distribution of income (monetary and non-monetary compensations: training, medical care, etc.).

The design of such contracts should give attention to the mandatory inclusion of definitions of access to and transfer of plant genetic resources and associated traditional knowledge related to the possibility of a future of intellectual property creation based on the assets transferred under the contract. This is to avoid non-observance of the interests of the party providing the plant genetic resources and traditional knowledge, the owners and custodians of the plant genetic resources and traditional knowledge who are involved in access to and transfer of these assets.

Special cases are those when the subject of the agreement is the transfer of plant genetic resources and traditional knowledge to foreign individuals and organizations as well as access to a particularly important plant genetic resource (*in terms of, for example, food policy of a country or related to human genetic resources or genetic resources of rare and endangered plant species, etc.*).

Due to the current trend toward introducing information sources containing data on plant genetic resources and traditional knowledge into the patent examination procedure, which is reflected in the inclusion in the required minimum documentation about these assets during the international search according to the procedure of the Patent Cooperation Treaty, it is necessary to create a single information array on traditional knowledge and plant genetic resources available for the purposes of patent searches and the inclusion of information on traditional knowledge and plant genetic resources in the patent. For this purpose, an information database on traditional knowledge and plant genetic resources must be created, their classification must be developed, their suitability for use must be ensured (*date of publication must be determined, translations into the languages available must be provided*).

Based on the need to create a legal mechanism for the involvement of genetic resources and traditional knowledge, as well as the owners and custodians making

a profit from the use of inventions that are based on these assets, it is proposed to develop a system of economic measures aimed at observation of interests of plant genetic resources and traditional knowledge owners and custodians given that the number of such entities may be very large—from individual nations and communities to scientific and commercial organizations and the state itself.

Possible options include such implementation models as creation of a system of paying royalties for the use of plant genetic resources and traditional knowledge in the creation of inventions. These royalties can be allocated for development, maintenance, conservation of plant genetic resources and traditional knowledge. This could also apply during the process of obtaining a patent for an invention based on the use of plant genetic resources originating from the traditional area of nature management or during the process of obtaining a patent for an invention based on the use of plant genetic resources attributed to rare and endangered species on the basis of existing legislation (*for example, listed in the Red List*) and international agreements. Further commercial use of this invention can stipulate payments aimed at conservation of this type of plant genetic resources.

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SAVING THE PAST AND THE PRESENT FOR THE FUTURE

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The Children's Ecological Society (CES) "Zumrad" was established in 1995. In 2000 it was officially registered as a Republican nongovernmental nonprofit organization (NGO). The mission of the Society is to rehabilitate children – orphans, homeless, educationally neglected children and children from poor families—through their voluntary involvement in solving environmental issues and training programs.

To achieve these goals CES "Zumrad" focused its activities on providing the beneficiaries with necessary skills and knowledge that will help them continue to be useful to society and fulfill their potential.

The Society holds annual plantings of nut trees and other fruit crops to enrich and restore forests in Karatag Gorge in Tursunzade District.

As part of the Tajikistan component of the GEF project entitled "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia" supported by UNEP and coordinated by Bioversity International in cooperation with the Institute of Horticulture and Vegetable Growing of the Tajik Academy of Agricultural Sciences, since 2008 CES "Zumrad" takes an active part

in agrotheaters, workshops and training events for schoolchildren. Students of Boarding School No.1 of Dushanbe participate as actors. Most of these children are orphans concerned with ecology in the community. Agrotheater events were prepared by students of secondary schools from a group of districts in the Republic of Tajikistan.

Special costumes depicting endangered species of fruit crops in Tajikistan were made for children. The stage was decorated with a banner displaying planting seedlings with children and logos of GEF, UNEP, Bioversity International and CES “Zumrad”.

The agrotheater represents such rare endangered species of fruit and berry crops as peach, apple, grape, pear, etc. The agrotheater’s program included riddles about fruits and berries, various quizzes, songs, dances, duets and poems.

Each performance was attended by more than 200-250 students from various schools and villages as well as representatives of the Khukumat District, nature conservation agencies, Dzhamota, farm, *dekhkan* enterprises and leaseholders. Agrotheaters were conducted with participation of representatives of Bioversity International and the Institute of Horticulture and Vegetable Growing of the Tajik Academy of Agricultural Sciences. Agrotheaters were held in the Boarding School No.1 of Dushanbe in Shahrinav, Gissar, Tajikabad and Rasht Districts as well as at fairs of trade exhibition of seedlings in Dushanbe.

In the summer 2010 in the Karatag Gorge of Labidzhay Canyon under the GEF project supported by UNEP and coordinated by Bioversity International, the Children’s Ecological Society “Zumrad,” in partnership with the Institute of Horticulture and Vegetable Growing of the Tajik Academy of Agricultural Sciences held a seminar on “Local fruit and nut crops varieties and their wild relatives’ agrobiodiversity conservation in Tajikistan,” which was attended by 25 students, all representatives of four children ecological clubs, including orphans, half-orphans and three students of the Tajik Agrarian University. The outcome of the workshop was the development of a gardening movement in children’s and students’ ecological clubs.

Theoretical and practical sessions with two trips to villages in Karatag Gorge were conducted as part of the workshop. During the trip, children became acquainted with fruit crops, particularly endangered local varieties and their wild

relatives. During the workshop, students made sketches, gathered plants for the herbarium, participated in conversations and discussions about local varieties and methods for their conservation. The participants were taught methods of grafting and budding. The children participated actively and expressed a desire to continue this work. Today, a new orchard has been established at the club “Lochin” in Shakhrinav District that contains mostly local varieties. In Nilu village of Gissar Distric, the “Green Patrol” from “Nilufar” club took part in the work of caring for fruit trees and cultivating local varieties of fruit and grape which are valued by the local population. A nursery for local varieties of fruit and nut crops and grape cultivars was established at the club “Archa” in Tursunzade District. In addition, walnut, juniper, almond, hawthorn, and other crops are cultivated in the nursery.

In the spring of 2011, workshop participants took part in the establishment of a demonstration plot in the Zumrad orchard, which is located in Karatag Gorge where valuable varieties of fruit and berry crops grow and where some of them are endangered. In future, with the support of the Project and the Institute of Horticulture and Vegetable Growing, it is planned to establish a nursery for the reproduction of valuable local varieties and forms of fruit crops and their wild relatives on this plot.

Cooperation with The Institute of Horticulture and Vegetable Growing of the Tajik Academy of Agricultural Sciences under the project allowed the involvement of students of CES Zumrad in the environmental movement for biodiversity and agrobiodiversity conservation, increasing their interest in the specially protected natural areas. Workers of CES Zumrad expressed their appreciation to representatives of Bioversity International and National Project Coordinator T.A. Akhmedov for their support and expressed hope for further cooperation.

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Section 2.
DIVERSITY OF FRUIT CROPS AND THEIR WILD RELATIVES AND PROBLEMS OF THEIR SUSTAINABLE USE

DIVERSITY, DISTRIBUTION AND CONSERVATION OF TARGET FRUIT CROPS IN CENTRAL ASIAN REPUBLICS

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Central Asia is one of the centers of origin of cultivated plants. More than 70 fruit crop species grow here. The climatic conditions of Central Asian countries are extremely diverse. Zaili and Jungar Alatau in Kazakhstan, Arslanbab and Kuk Yangak massifs in Kyrgyzstan, mountain and piedmont of areas Kopetdag, the Greater and Lesser Balkhan in Turkmenistan, Khorezm and Bukhara oases, southern areas of Uzbekistan and extremely dissected mountainous areas of Tajikistan differ from each other greatly. For several centuries species of fruit trees, those most adapted to the arid climate through drought resistance, salt resistance and resistance to stress factors have been forming under these conditions. They are preserved in natural habitats (*in situ*), notable for their high intraspecific diversity, and are of great value for improvement of local collections. Apple trees (*Malus* M.), walnut (*Juglans regia* L.), almond (*Amygdalus* L.), pistachio (*Pistacea vera* L.), some species of barberry (*Berberis* L.), hawthorn (*Crataegus* L.), sea buckthorn (*Hippophae* L.), etc. are traditionally used and of the greatest value for food among wild fruit species.

Central Asia is rich in local varieties and wild forms of cultivated species of fruit crops. Here traditional breeders created highly productive varieties of fruit crops with high quality fruit adapted to local conditions. They are transferred through generations and kept on farms. Local varieties are the carriers of major economically valuable traits and source material for creating new varieties of intensive type.

But now wild and cultivated species of fruit plants are constantly exposed to human impact. The extinction of ancient varieties of local fruit trees and decrease in their wild relatives' habitats is observed everywhere. Implementation of the project "*In situ*/on- farm conservation and use of agrobiodiversity (fruit crops and their wild relatives) in Central Asia" is of great importance in conservation of the biodiversity of fruit crops and their wild relatives in the Central Asian region. The following fruit crops were of priority during the study:

- in Kazakhstan – apple, grape, pear and apricot;
- in Kyrgyzstan – apple, grape, pistachio, walnut, alycha, buckthorn and currant;

- in Tajikistan – apple, grape, pear, apricot, pistachio, walnut, buckthorn, peach and mulberry;
- in Turkmenistan – apple, grape, pear, apricot, pistachio, pomegranate, almond, alycha and fig;
- in Uzbekistan – apple, grape, pear, apricot, pistachio, walnut, pomegranate and almond.

To assess the distribution and extent of the diversity of priority fruit crops and their wild relatives in farm, *dekhkan* and lease enterprises, field surveys in 29 regions of Central Asia were regularly conducted. As a result, the habitat of priority crops was established:

- apple, pear, grape and apricots grow in almost all regions;
- nut crops, sea buckthorn, black currant are concentrated mainly in the mountainous and piedmont areas;
- sub-tropical crops, being thermophilic, grow in the southern areas.

The morphological and basic industrial and biological characteristics of identified local varieties and forms of the target fruit crops were described and a database was created to assess the distribution and extent of the diversity of priority crops.

Fruit crop diversity in farm enterprises consolidating 24 genera of target crops:

Seed fruit crops:
Apple - *Malus* Mill.
Pear - *Pyrus* L.
Quince - *Cydonia* Mill.
Hawthorn - *Crataegus* L.

Stone crops:
Apricot - *Armeniaca* Mill.
Peach - *Persica* Mill.
Plum - *Prunus* Mill.
Cherry - *Cerasus* Juss.
Oleaster - *Elaeagnus* L.
Unabi - *Ziziphus* Mill.

Nut crops:
Walnut - *Juglans regia* L.
Almond - *Amygdalus* L.
Pistachio - *Pistacia vera* L.

Subtropical crops:
Pomegranate - *Punica* L.
Fig - *Ficus* L.
Persimmon - *Diospyros* L.
Mulberry - *Morus* L.

Berry crops:
Grape - *Vitis* L.
Облепиха- *Hippophae* L.
Currant - *Ribes* L.
Strawberry - *Fragaria* L.
Raspberry - *Rubus* L.
Barberry - *Berberis* L.

Citrus crops:
Citrus - *Citrus* L.

Great attention is paid to the intraspecific diversity of target fruit crops in farm enterprises. Project executing units revealed 706 local varieties and forms of the target fruit crops and their wild relatives, including apple (*Malus* Mill.) 204; pear (*Pyrus* L.) 56; apricot (*Armeniaca* Mill.) 133; peach (*Persica* Mill.) 10; alycha (*Prunus cerasifera Ehrh*.) 19; grape (*Vitis* L.) 107; pomegranate (*Punica* L.) 19, fig (*Ficus*

L.) 7; walnut (*Juglans regia* L .) 57; pistachio (*Pistasia* L.) 37; almond (*Amygdalus* L.) 25; mulberry (*Morus* L.) 15; buckthorn (*Hippophae* L.) 9, currant (*Ribes* L.) 5.

The concentration of local varieties and forms of target fruit crops varies among administrative districts and the Central Asian countries. The greatest diversity of local varieties and forms is found as follows:

- apple in Kazakhstan;
- apricot in Uzbekistan, Tajikistan;
- pomegranate Turkmenistan, Uzbekistan, Tajikistan;
- walnut in Kyrgyzstan;
- grape everywhere.

The following factors having an impact on agrobiodiversity in farm enterprises were observed in all Central Asian republics:

- social factors: education, social status, age;
- cultural factors: local traditions;
- environmental factors: altitude above sea level, temperature, soil conditions, etc.;
- land resources: soil type, soil texture, soil salinity, availability of irrigation water;
- abiotic factors: winter frost, late spring frosts;
- market infrastructure: distance to products' markets, the availability of processing industry;
- selection of varieties by farmers: the market value, a high degree of usefulness for the families.

Along with the above mentioned factors that significantly affect the state of agrobiodiversity in farm enterprises and in most cases lead to reduction of the habitat and extinction of local varieties and forms of fruit crops and their wild relatives, there are additional factors:

- introduction of foreign breeding varieties;
- ecological status of habitats;
- anthropogenic activities: grazing, nonregulated harvesting, new land development;
- lack of awareness of the value of local varieties.

To conserve local varieties and forms of fruit crops and their wild relatives, the project's executing units carried out extensive work on their reproduction and distribution and in improving public awareness about their value.

A total of 57 nurseries were created in Central Asian republics on the basis of farm enterprises, including 11 in Kazakhstan, 7 in Kyrgyzstan, 10 in Tajikistan, 10 in Turkmenistan, and 19 in Uzbekistan. More than 240 promising varieties and forms of the target fruit crops are reproduced in these nurseries, including: 80 apple, 29 pear, 59 grape, 33 apricot, 6 alycha and peach, 7 walnut, 11 almond 13 pomegranate and one currant.

For large-scale promotion of local varieties of fruit crops in the Central Asian countries, 65 demonstration plots were established, including: 12 in Kazakhstan, 7 in Kyrgyzstan, 14 in Tajikistan, 10 in Turkmenistan and 22 in Uzbekistan. Here

farmers have the opportunity to get acquainted with promising varieties and forms of fruit crops and the varietal characteristics of their cultivation and use, and identify their strengths and weaknesses.

To raise public awareness about the value of local varieties of fruit crops and their wild relatives, regular appearances are made in the media, articles are published in magazines and newspapers, round tables are organized and workshops are held, and booklets, posters, information sheets, etc. are published.

Thus, Central Asian countries have a rich collection of fruit crops and grape. Tactics to help farmers in the conservation of local varieties and forms of fruit crops in farm enterprises, *in situ*/on farm programmes were developed.

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NURATAU RANGE WALNUT FORMS: BIODIVERSITY FOR BREEDING AND POTENTIAL FOR REPRODUCTION IN UZBEKISTAN

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Uzbekistan is one of the countries representing the center of the natural origin of walnut in the region of its ancient culture. Here, to the present day wild walnut stands are conserved and are characterized by exceptional varietal diversity according to various traits and properties. The current habitat of wild walnuts in Uzbekistan occupies mainly three isolated mountainous area at a distance of more than 250 km in the western Tien Shan (Bostanlyk and Akhangaran districts of Tashkent Region), the Nuratau Range (Farish district of Jizzakh Region) and southern spurs of the Gissar range (Denau district of Surkhandarya Region). In the Nuratau Range, walnut plantings occupy small areas, mainly in floodplains and valleys of small rivers due to the dryness and high summer temperatures.

In order to replenish the existing walnut breeding gene pool of Uzbekistan with promising new forms, inspections of tree plantations with walnut in Nurata Reserve and the neighboring Farish Forest were conducted. The work was conducted under grants from project PL-480 funded by the U.S. Department of Agriculture (2003-2004) and the Italian-Uzbek joint project (2010) co-financed by the Italian Ministry of Foreign Affairs under the “Joint Program of Cultural and Scientific Cooperation between the Governments of Italy and Uzbekistan”.

The selection of trees was carried out according to directly economically valuable traits and properties. In the field, selected trees were described according to the main morphological characteristics: height, stem diameter, parameters and shape of the crown, stem height, number of scaffold branches, type of fruiting and yield, vulnerability to pests and diseases, general condition, etc.

A full morphological assessment of fruit (nuts) was conducted under laboratory conditions. For this purpose, nut shape, shape of its apex and base, the development of the rostel and rib were identified, sculpture and color of endocarp was studied, nut weight and its parameters, the thickness of the shell, the weight of the kernel and its output, the development of internal partitions, the extractability of the kernel, its taste, kernel shell color, etc. were identified.

Despite the fact that the selection was focused, a significant polymorphism was observed in economically important traits and properties of the selected trees.

This creates the required prerequisites for selection of the most valuable of them based on a set of key economically important traits – nut weight, shell thickness, weight of the kernel and its output, the extractability of the kernel, etc., with an account of productivity and sanitary state of trees. The selected trees are then subdivided into four categories according to the nut weight: large-fruited with heavy nuts (weight 12.1-14.0 g) and very large-fruited with the heaviest nuts – 14.1 g or more; medium-fruited - nut weight of 10.0-12.0 g, and small-fruited, light nuts – 8.0-9.9 g. Wild forms with larger nuts weight – 51 out of 64 examined forms (79.7%) – dominate among the selected in the field. Trees with codes 307-N (18.6 ± 0.24 g), 18-N (16.5 ± 0.25 g), 95-FRSH (16.0 ± 0.20 g), 10-N (17.6 ± 0.93 g), 29-N (18.7 ± 0.35 g), 33-A (16.6 ± 0.24 g), etc. are notable for the greatest weight. They are followed by the trees with an average nut weight of 14.1% among the 64 forms examined. Only 4 (6.2%) forms are listed under the category of the smallest ones.

Fifteen forms (23.4%) can be considered thin-shelled (nutshell thickness of 1-1.5 (1.6 mm). They are of the greatest breeding interest since the thickness of the shell is associated with such traits as ease of extractability and the output of kernel from the mass of the nut. Most of the other forms are characterized by larger (1.7-1.9 mm) (40.6%), or thick (2 mm or more) nutshell (36.0%). The maximum thickness of the shell reached 2.3-2.6 mm. Note, however, that the character of the extractability of the kernel does not always depend on the thickness of the shell. Thus, despite the considerable thickness of shell of 10-N, 29-N forms, the kernel is removed relatively easily and whole after cracking. At that point the rate of kernel output decreases but large-fruited forms such as 29-N, 10-N, and 18-N are of interest to synthetic walnut breeding for fruit size.

19 (29.7%) forms are characterized by relatively high kernel output (at least 50% by nut weight). Form 31-A (57.3%), 304-FRSH (58.3%), 81-N (58.8%) have the highest kernel output. Kernel output ranging from 45.0 to 50.0% was observed in 28 trees (43.8% of examined trees).

To conclude the brief analysis of the results of the walnut breeding survey in the Nurata Range, we note that, according to the complex of the main biomorphological and economically valuable traits, 10 of 65 selected trees can be attributed to those that are of direct breeding and practical interest. These are large-fruited forms 20-N, 307-N, 308-N from Nurata Reserve, 305- FRSH, 306-FRSH from Farish Forest and 31-A from Andigen-sai tract as well as medium-fruited forms coded 303- FRSH, 304-FRSH, 92-FRSH and 80-FRSH from Farish Forest (see Table). They are recommended for reproduction in Uzbekistan and further in-depth study of the yield, flowering and fruiting peculiarities, sanitary status, and vulnerability to major adverse environmental factors.

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Table: **New forms of walnut from the Nuratau range having potential for reproduction in Uzbekistan**

Tree code	Location and coordinates				N u t				Shell thickness, mm	Kernel weight, g	Kernel output, %	Extractability of the kernel
	Local name	Altitude above sea level, m	northern latitude	eastern longitude	weight, g	length, mm	width, mm	thickness, mm				
20-N	Tykchasay Ukhum village	979	400 301 56. 2	0660 461 46. 9`	12,5 ±0,24	32,5 ±0,26	35,3 ±0,17	33,6 ±0,16	1,6 ±0,02	6,7 ±0,15	53.6	Whole
307-N	Madjerum-say	674	400 351 28. 5`	0660 261 29. 5`	18,6± 0,24	39,3 ±0,21	36,3 ±0,22	40,1 ±0,36	1,5 ±0,01	9.2± 0.17	49.4	Whole, sometimes in halves and quarters
308-N	Khayatsay	968	400 311 38. 1`	0660 461 23. 5`	16,1± 0,35	37,7 ±0,25	34,3 ±0,16	37,1 ±0,20	1,4± 0,02	8.3 ±0.16	51.6	In halves and quarters, sometimes whole
305-FRSH	Yamchisay	880	400 201 42. 6`	0670 111 54. 2`	12,7 ±0,19	34,2 ±0,27	32,9 ±0,21	34,0 ±0,16	1,2 ±0,01	6.6 ±0.14	52.0	In halves and quarters
306-FRSH	Yamchisay	906	400 201 38. 4`	0670 111 53. 9`	12,2± 0,19	36,5 ±0,27	31,8± 0,20	33,7 ±0,27	1,1 ±0,01	6.2 ±0.10	50.8	Whole, more rarely in halves
31-A	Andigensay	662	400 351 23. 0`	0660 451 48. 2`	13,9 ±0,23	36,1 ±0,32	31,2± 0,19	34,9 ±0,21	1,5 ± 0,03	7.96± 0.13	57.3	Whole
303-FRSH	Uchmasay	920	400 251 15. 1`	0670 011 31. 9`	11,0± 0,19	38,0 ±0,32	31,6 ±0,30	31,3 ±0,22	1,1 ±0,02	5.6± 0.12	50.9	Whole or in halves and quarters
304-FRSH	Uchmasay	859	400 251 53. 8`	0670 001 27. 3`	10,8± 0,20	36,2 ±0,15	31,6 ±0,17	32,2 ±0,17	1,0 ±0,01	6.3± 0.11	58.3	In halves or quarters, sometimes whole
92-FRSH	Uchmasay	1025	400 251 41. 9`	0660 591 30. 3`	10,9 ±0,19	36,9 ±0,26	31,9 ±0,27	31,9 ±0,20	1,5± 0,05	5.55± 0.12	50.9	Whole
80-FRSH	Sevatliksay	976	400 201 08. 4`	0670 131 29. 6`	10,7 ± 0, 23	35,8 ±0,23	34,9± 0,32	34,5 ±0,29	1,5 ±0,03	5.2± 0.22	48.6	Whole

LOCAL VARIETIES AND WILD FORMS OF GRAPE IN UZBEKISTAN AND THEIR BREEDING VALUE

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Grape is one of the oldest agricultural crops. It is distributed over a vast territory from the Atlantic coast of Europe across the southern zone of the Euro-Asian continent. It is cultivated in South and North Africa, on the west coast of North America (California), in Mexico, South America, Australia and New Zealand. Today, grape is one of the most valuable and important agricultural plants. It is grape that is the second in annual largest yields among fruit crops. Most of the world's 9000 grape varieties belong to Euro-Asian species *Vitis vinifera* L.

The geographical and ecological characteristics of centers of origin of the Euro-Asian species make it possible to divide them into the Western-European group of the Black Sea basin and the Eastern group of grape varieties (Arzumanov 1990). Typical representatives of the Eastern varieties are Husayne, Nimrang, Tayfi rozoviy, Katta kurgan, Kishmish black and white and Sultani.

The local grape population in Uzbekistan is particularly distinctive and diverse. People in the region have always treated grape with great respect, thanks to which local varieties have survived almost intact. This original population has long attracted the attention of scientists and breeders. Systematic ampelographic studies of the area began as far back as 1924-1926 and are being continued today. Grape genetic resources include those in Tashkent, Khiva, Khorezm oases, the Ferghana Valley and the southern regions of the country (Baranov 1927, Haydarkulov 1957, Katz 1936, Negrul 1959, Ruban 1972, Tabanali 1960, Vavilov 1960).

Today, ampelographic collections of research institutes contain more than 460 rare endemic varieties and wild forms of grape. However, these resources are not exhausted. It is necessary to conduct a detailed survey in the area to reveal microzones of concentrations of local varieties and wild forms, especially in remote mountainous areas which, according to N.I. Vavilov, represent optimal conditions for revelation of varietal diversity, conservation of physiological types and are perfect isolators protecting varietal wealth (Vavilov 1960).

The need for a detailed survey of the territory of the Republic results from the fact that due to cultivation of land, construction of reservoirs and other large structures, local populations of grape may be irretrievably lost.

Time-independent studies of involved varieties and wild forms of grape made it possible to identify varieties and forms that can be used in production without breeding improvement. Of the samples found during the past 20-30 years, Angur fakhri, Kora nimrang, Husayne siyo, Kara chilyaki, Ruzbari, Tuda gul, Sigir yamchak, Soyfi and other varieties are recommended for production.

The gene pool of grape in Uzbekistan has long been used by breeders from many countries to produce table and seedless varieties. Many high-quality varieties (based on Uzbek varieties) are in particular produced in Armenia, Moldova, Russia, Ukraine, Italy, USA and other countries.

The standard grape collection of Uzbekistan includes 10 new varieties bred based on local varieties. In recent years, we have studied 150 rare endemic species and 60 wild forms of grape. A comprehensive study of the major biological and economic traits and properties showed that Bozori, Erta pishar and Zogak peshpazak varieties are the most promising for breeding the early maturity trait. The vegetation period of these varieties from budding to full ripeness takes 98-105 days. The results showed that breeding of a large bunch and large berry traits must include Kara asma, Ruzbari, Kush boki and Sigiri yamchak varieties. Most of these varieties are notable for their long-term storage capacity. Seedless trait carriers, besides those already-known varieties, are Krasniy nursuksky, Chumchuk tili, Kishmish duoba and Kishmish botyr varieties.

Today, breeders and wine-growers around the world work on the problem of breeding varieties resistant to major pests and diseases. At the same time, increasing attention is paid to the involvement of indigenous varieties in this process. Traits of resistance to fungal diseases such as oidium (*Uncinula necator*) are available in some Uzbek varieties but to a lesser extent. During hybridization with these varieties, the trait of offspring stability may becenhanced. These varieties include the Kara djandjal variety, which along with resistance to oidium is the source of economically valuable traits such as a large bunch and fine large berry.

In the mountain areas of Uzbekistan, wild forms of grape grow that are the carriers of genes determining resistance to biotic and abiotic environmental factors. Wild grape grows at altitudes not exceeding 1000 m above sea level. It is found as continuous thickets and small groups. In Kashkadarya Region the most interesting forms are found in the Yargaksay River (a tributary of Kashkadarya River) Gorge. In the mountainous districts of Tashkent Region grape thickets are found in the valleys of Chatkal, Ugam, Djuzum say and Karankul say Rivers.

Natural and almost uniform grape thickets are found in Surkhandarya Region in the valleys of Tupalang and Sangardak Rivers. Morphologically, these forms are similar to the wild forest grape *Vitis vinifera* subsp. *sylvestris* Gmel. From the wild thickets, the forms which *in vivo* were characterized by high productivity and had no damage associated with diseases and frost were involved in the collection. Transfer of wild forms into cultivation contributed to the formation of large well-made bunches.

In addition, we have identified forms to be used in breeding of oidium and frost resistance traits. These include Dzhuzumsky 1-78 and Dzhuzumsky 10-78 forms found in the mountainous areas of Tashkent Region. Karankulsay 16-78

and Karankulsay 21-78 samples are the carriers of the frost resistance trait. Crop capacity of samples reached 200-210 kg/ha. Thus, field surveys in Uzbekistan showed that work on the discovery of new microzones of endemic varieties and wild forms of grape growth should be continued. The most sound way to conserve revealed species and forms is to include them in collections.

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FRUIT CROP DIVERSITY AND DISTRIBUTION AMONG FARM ENTERPRISES IN UZBEKISTAN

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Apple, pear, peach, quince, cherry, plum, apricot, grape and other fruit crops are grown in farm enterprises and orchards in Uzbekistan. Their population is mainly represented by local varieties. Soil and climatic conditions in the Republic have a significant influence on biological features and morphological characteristics of local fruit crop populations. For this reason, local collections of fruit in the Ferghana and Zarafshan valleys, Khorezm and Bukhara oases, mountain and piedmont areas of the Republic differ significantly from each other.

Adaptability to an arid climate, drought resistance, resistance to environmental stress factors wit are the common biological features of the local collection of fruit crops. They have been formed over thousands of years under local conditions and are currently cultivated in farm enterprises.

Uzbekistan is part of the Central Asian center of origin of cultivated plants – more than 50 fruit crop species grow in its territory. Wild species have been preserved in natural habitats (*in situ*). They are notable for high intraspecific diversity and are of great importance to the preservation of ecosystems. The wild fruit species of the greatest value for food are the following traditionally used fruits: apple (*Malus* M.), walnut (*Juglans regia* L.), almond (*Amygdalus* L.), pistachio (*Pistacia vera* L.), hawthorn (*Crataegus* L.), some barberry species (*Berberis*), etc.

Field surveys conducted as part of the GEF "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia" project supported by UNEP and coordinated by Bioversity International showed that the process of form creation and selection of the best samples is still in progress in all regions of the Republic. New varieties and forms of apple, apricot, pear, grape, pomegranate and other fruit crops were identified. A large number of promising

forms of walnut, pistachio and almond were selected from wild trees. As a result of field surveys, fruit crops' priority habitats were identified.

It was discovered that apple, apricot and grape grow in almost all regions of Uzbekistan. Nut crops (almond, walnut and pistachio) are concentrated mainly in the mountainous and piedmont areas of Tashkent, Surkhandarya, Kashkadarya and Jizzakh Regions. Subtropical crops such as thermophilic grow in Kashkadarya, Surkhandarya Regions and the Ferghana Valley. Today, pomegranate and fig are cultivated using covering crops in all areas of the Republic. A fair yield of pomegranate and fig is produced in the Republic of Karakalpakstan. Many fruit crops are cultivated in farm enterprises. Their diversity combines more than 24 genera.

They include **pomaceous crops:**

- Apple - *Malus* Mill.;
- Pear - *Pyrus* L.;
- Quince - *Cydonia* Mill.;
- Hawthorn - *Crataegus* L.

Stone fruit crop:

- Apricot - *Armeniaca* Mill.;
- Peach - *Persica* Mill.;
- Plum - *Prunus* Mill.;
- Alycha - *Prunus cerasifera* Ehrh.;
- Cherry - *Cerasus vulgaris* Mill.;
- Sweet cherry - *Cerasus avium* (L.) Moench.;
- Mahaleb - *Cerasus mahaleb* (L.) Mill.;
- Oleaster - *Elaeagnus* L.;
- Unabi - *Ziziphus* Mill.

Nut crops:

- Walnut - *Juglans regia* L.;
- Almond - *Amygdalus* L.;
- Pistachio - *Pistacia vera* L.

Subtropical crops:

- Pomegranate - *Punica granatum* L.;
- Fig - *Ficus* carica L.;
- Persimmon - *Diospyros lotus* L.

Small-fruit crop:

- Grape - *Vitis* L.;
- Currant - *Ribes* L.;
- Strawberry - *Fragaria* L.;
- Raspberry - *Rubus* L.;
- Barberry - *Berberis* L.;
- Sea buckthorn - *Hippophae* L.

Some citrus fruits, such as lemon - *Citrus limon* (L.) Burm, orange - *C.sinensis* Osbeck and mandarin - *C.retculata* Blanca, are also grown in farm enterprises. Target crops are very rich in diversity and species. More than 10 types of fruit crops are cultivated in farm enterprises:

- Asian wild apple - *M. sieversii* (Ldb). M. Roem.;
- Domestic pear - *P. communis* L.;
- Bukhara pear - *P. bucharica* Lit;
- Common apricot - *A. vulgaris* L.;
- Black apricot - *A. dasycarpa* (Ehrh) Pers.;
- Pistachio - *P. vera* L.;
- Walnut - *J. regia* L.;
- Common almond - *A. communis* L.;
- Bukhara almond - *A. bucharica* Korsh.;
- Pomegranate - *P. granatum* L.;
- Grape - *V. vinifera* L.

A significant intraspecific diversity of fruit crops is observed. However, the concentration of local varieties and forms of target fruit crops varies in different administrative districts. The greatest diversity of local varieties and forms is observed for: apple and pear in Tashkent, Namangan and Khorezm Regions; apricot in Bukhara, Surkhandarya, the Fergana valley and Khorezm oasis; pistachio in Surkhandarya and Samarkand Regions; almond in Kashkadarya, Samarkand and Tashkent Regions; walnut in Tashkent, Jizzakh and Surkhandarya Regions; pomegranate in Surkhandarya, Kashkadarya Regions and the Ferghana valley; and grape in Samarkand Region and elsewhere in the Republic.

Some of the examined varieties and forms are widely distributed in the Republic. They include varieties of apricot such as Hurmai, Subkhanu, Arzami, Isfarak; grape such as Taifi rozoviy, Husayne, Kishmish black and pomegranate such as Kazake Anor, Kizil Anor. In addition, there are varieties that have a small habitat and are distributed only in selected areas of the Republic. They include varieties of apple (Letniy Khazarasp and Zimniy Khazarasp) in Khorezm Region, apricot varieties (Bodomak, Iris) in Bukhara Region, apricot varieties (Djambil, Djavzak) in the Republic of Karakalpakstan, a grape variety (Olomon Tuydi) in Surkhandarya Region.

Uzbekistan has a rich local collection of fruit crops and their wild species. They are well adapted to local soil and climatic conditions and are the carriers of important economically valuable traits representing a great value as source material for breeding new varieties.

Despite the value of local varieties, a reduction of their habitat and extinction of individual samples are observed. There is erosion of local varieties of fruit crops and their wild species. The most important factors affecting erosion include introduction of foreign breeding varieties, human activities and—the most important—lack of awareness on the part of the population of the value of local varieties. It is necessary to improve farmers' knowledge and skills and provide them with the required manuals on agrobiodiversity management.

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BERBERIS L. GENUS BIODIVERSITY IN CENTRAL ASIA

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Barberry, a shrub of the genus *Berberis* L. of the barberry family (*Berberidaceae* Torr. et. Gray), consists of 497 species that are widespread in Europe, Asia, Africa, North and South America. It has been traditionally cultivated as an ornamental, fruit and medicinal plant.

Based on current geographical distribution of species and fossil residues, *Berberis* L. genus is undoubtedly of ancient origin. Distribution of this genus species in North, Central and South America, throughout Europe including the Caucasus and the Crimea, and in East and Central Asia makes it possible to assume that the genus emerged probably in the Cretaceous period (Arifkhanov *et al.* 1981).

Scientific research on the species is associated with C. Linné. In 1753 he first referred two species known to botanical science at that time - common barberry (*Berberis vulgaris* L.) and Cretan barberry (*Berberis critica* L.)—to a genus. At the end of the eighteenth century five species of barberry were known, including Siberian barberry (*Berberis sibirica* Pall.), and 150 barberry species were described in the nineteenth century.

Later on, through the proposal of S.K. Schneider (1905), species of *Berberis* L. genus were divided into two botanic-geographical groups—*Septentrionales* C.K. Schneider (species of Eurasia and North America) and *Australes* C.K. Schneider (South American species). Eurasian and South American barberry species differ greatly. Flowers of the South American species are of dark orange color and their evergreen leaves are connected with long paniculate inflorescences. Eurasian species have yellow flowers, red and dark-blue berries and they are mostly deciduous plants. C.K. Schneider found 22 sections in *Berberis* L. genus covering 156 barberry species and a further 200 species, of which six species were of Central Asia (Tulyaganova 1972).

Central Asian barberries are known to us mainly by the work on the *Berberis* L. genus conducted by B.A. Fedchenko (Fedchenko 1953). He identified seven barberry species in Central Asia, including three species in Uzbekistan. In the 1950-70s of the past century, studies on barberries were conducted in the Central Asian republics through the work on regional flora genuses. Of these, the largest and most detailed is the genus work by V.S. Kornilova in Kazakhstan (eight species). V.I. Zapryagaeva (Zapryagaeva 1964) identified six barberry species for the Pamir-Alay. The author considers *Berberis oblonga* Rgl. and *Berberis heterobotrys* Wolf, previously equated with *Berberis oblonga* Rgl, to be the most widespread species.

G.F. Protopopov worked on the genus *Berberis* L. in Kyrgyzstan, identifying six species. According to V. Nikitin, three species of barberry are found in Turkmenistan. L.N. Slizik (1964), having critically examined *Berberis* L. genus for Central Asia, identified 11 species. K.T. Arifkhanov and T.I. Slavkina (Arifkhanov *et al.* 1981) believe that 12 species of barberry inhabit Central Asia and Kazakhstan.

More detailed studies of the *Berberis* L. genus in Central Asia were conducted by M. Tulyaganova (Tulyaganova 1972). She identified eight species for the region. Her work clarified the plant species composition of this genus. As a result, only eight of the 12 names previously listed as species remained valid and the rest are referred to as synonyms (including Oblong barberry (*Berberis oblonga* Rgl.), heteropodal barberry (*Berberis heteropoda* Wolf.) and smooth-edged barberry (*Berberis integerrima* Bge). Heteropodal barberry grows mainly in the East and Central Tien Shan, oblong and smooth-edged barberries grow in the Western Tien Shan and are also distributed in the Western Pamirs.

Barberries in Central Asia, mainly deciduous mountain shrubs, are notable for a significant polymorphism. They easily form natural hybrids which are usually fertile and, in turn, are crossed with original forms, enhancing the polymorphism that causes instability of the species' typical traits (Berdiev 1992). Significant diversity of natural hybrid forms is established in areas of species mixed growth. Many such hybrid forms in old times were mistakenly approved as independent species (*Berberis multispinosa Zapr., B. heterobotrys* E.Wolf., *B. ilensis* M. Pop., *B. stolonifera* Koehne.et. E. Wolf., *B. turcomanica* Karel.).

Oblong barberry (*Berberis oblonga* Rgl.) has the most important economic value. In 1877 Eduard Regel was first to identify this barberry as a special form - *Berberis heteropoda* Schrenk var. oblonga Rgl. In his view this species is widespread in Turkestan and it differs from typical *Berberis heteropoda* by its oblong elliptical, dark bluish-purple berries. Later, researcher C.K. Schneider (1905) described this barberry as a separate species—*Berberis oblonga*—which differs from *Berberis heteropoda* by two sessile ovules, elliptical berries, multiflowers and partially ramiparous inflorescences. In its natural habitat, the height of the shrub is up to 3 to 4 m. The rind of old shoots is dark-gray with shallow longitudinal cracks; the rind of young branches is brown and also with longitudinal grooves and wide, up to 2 cm long, tripartite thorns. Annual shoots are reddish-brown with hard simple thorns. Leaves on short shoots are in bunches, on innovation shoots are alternate, up to 5 cm long and up to 2 cm wide, with a slightly toothed or smooth-edged margin.

Inflorescences are racemose or paniculate, with 10-30 flowers, 3-4 cm long. The flowers are quite large—up to 1 cm in diameter. There six yellow petals. The first berries ripen in mid-September. Berries are 9.9±0.04 mm long and 5.1±0.04 mm in diameter; they are purple-black when ripe, blue-black with a waxy coating during the full ripeness period. Oblong elliptical berries prevail. The bunch contains 8-25 berries. The weight of a bunch is 1.5-3.2 g. Average weight of a berry is 0.2 ± 0.003g. Weight of 100 berries is 17-23 g. The peel is thick and coarse, the pulp is dark red, sour and edible. The sugar content ranges from 9.8 to 15.5% per mg, malic acid ranges from 11 to 12% per mg, vitamin C from 462 to 970 mg% (Tkachenko 1972). Berries are mostly two-seeded; the seed length

is 5.7±0.04 mm, the diameter 2.4±0.03 mm. Seed weight is 0.02±0.001g. The weight of 1000 seeds ranges from 13 to 16 g. The output of pulpy juice from 1 kg of fresh berries is 60-70%, net seeds are 20-22%. Seeds are glossy, dark brown and fine-netted when fully ripe and have a true physiological dormancy.

Sometimes shrubs with surprisingly large fruits up to 14mm are found in natural thickets of oblong barberry. Such large-fruited forms were mentioned by V.I. Zapryagaeva for the Pamir-Alay (Zapryagaeva 1964). In her view, large-fruited forms occur spontaneously in various parts of the natural habitat of barberry. Such a large-fruited form of oblong barberry was found the Sidjak mountain village in the western Tien Shan. The length of berries is 12.1±0,15 mm. The diameter is 7,7±0,13 mm. The average weight of a berry is 0,5±0,02. The weight of 100 berries ranges from 38 to 45 g. Seeds in such berries are also large – 2.5±0.08, seed length is 6.8±0.09 mm, diameter 3.4±0.05 mm. The weight of 1000 seeds is 18-23 g.

The habitat of oblong barberry is limited by the Pamir-Alay and the western Tien Shan Mountains. In Uzbekistan, its main habitats are attributed to the Chatkal, Pskem, Ugam and Kuramin ranges; in Tajikistan, the Gissar, Turkestan and Zarafshan ranges, in Kyrgyzstan the Chatkal, Uzunahmat, Alay and Fergana ranges.

Heteropodal barberry (*Berberis heteropoda* Schrenk) was described by S.K. Schrenk (1841) from the Jungar Alatau. The height of the shrub is up to 3 m. Sometimes the diameter of some individual stipes reach 8-10 cm. The leaves are obovate up to 6 cm long and 2-4 cm wide. The spines are simple, more rarely tripartite 1-3 cm long. The flowers are orange-yellow, 1 cm in diameter, on pedicels 0.6-1.2 cm long, put together in numerous bunches 2-5cm long. There are 5-8 flowers in a bunch. The berry is up to 12 mm in diameter, globular bluish purple-black with bloom. There are 4-6 seeds in a berry. The number of full grain seeds is small, the others are underdeveloped. Seeds are obovate with a convex back and a concave belly, dark brown, covered with pattern of small net, 4-6 mm long, 2-3 mm in diameter. The weight of 1000 seeds is 13-17 g.

This species is widely spread in the mountains at an altitude of 1100-2200 m above sea level. However, in eastern part of the Inner Tien Shan it is the dominant representative of this genus. It grows on floodplains of mountain rivers and on slopes of mountain tree and shrub zones. V.I. Tkachenko's (Berdiev 1994) studies showed that of local barberry species in the areas of the Inner Tien-Shan, spontaneous hybrids between *Berberis heteropoda* and *Berberis oblonga* are widespread. In addition, in a number of places the hybrid gene process is so significant that a hybridization of original forms takes place. As a result, variability of plants by size and form of inflorescences and berries is increasing.

Back in the nineteenth century, Eduard Regel, having studied the diversity of this species, divided it into the following four varieties:

1. *Berberis heteropoda* f. *coerulee* – berries are large, globular, with blue bloom;
2. *Berberis heteropoda* f. *elliptica* – berries are elliptic, blue with bluish bloom;
3. *Berberis heteropoda* f. *densiflora* – bunch is very dense, berries are small and blue;
4. *Berberis heteropoda* f. *oblonga* – berries are oblong, dark blue with a bloom (later transferred to the category of separate species - *B. oblonga* Rgl.).

The habitat of the species covers Jungar Alatau, Alatau, the Eastern and Central Tien Shan and Zaili Alatau. Thickets occur in Tarbagatay, Tabolga River Gorge, on the southern slope of the the Zaili Alatau, in the area of the upper reaches of the Small Almatinka River, near Lake Issyk-Kul and in the Djeti-Oguz Valley.

Smooth-edged barberry (*Berberis integerrima* Bge.) was described by Bunge in 1843 based on a collection made by Lehman in the basin of the Zarafshan River. In the wild, it is a branchy shrub 2-3 m in height. Its old shoots are gray; the young shoots are reddish-brown. Leaves are 3-3.5 cm long, 1.5-1.7 cm wide, leathery, narrow or wide obovate, which gradually become usually smooth-edged petiole. The inflorescences are racemose 6-7 cm long. There are from 15 to 32 flowers. The flowers are 8-9 mm in diameter and 10-12 mm long. There are 17-24 berries in one bunch; they are oblong elliptic, ovoid, purple-red during ripening and dark purple with a bluish bloom when fully ripe. Berry length is 9.0±.13 mm, diameter - 5.5±0.10 mm. The weight of berries is 0.2±0.01, while the weight of 100 berries is in the range of 16-20 g. Berries are mostly two-seeded. Seeds are oblong, furrowed, dark brown, 6.0 ± 0.3 mm long and 2.9 ± 0.07 mm in diameter. The weight of 1000 seeds is 15-16 g. The output of pulpy juice from 1 kg of fresh berries is from 65% to 72% and net seeds range from 20 to 24%. The habitat of the species covers the Tien Shan and Pamir-Alay Mountains and Iran.

Nummular barberry (*Berberis nummularia* Bge.) was also described by Bunge in 1843 based on a collection made by Lehman in the basin of the Zarafshan River. It is very close to the previous species, differs from it only by globular pink-red or bright red berries. In the wild it is a branchy and spiny shrub 3-4 m height. Its leaves are leathery, obovate and smooth-edged. The flowers are yellow, put together in long multiflowered bunches with pink axes. It usually flowers in May and is very decorative during fruiting when large bunches with bright red berries completely cover the shrub.

Inflorescences are axillary, racemose, with 30-44 flowers, 6-7 cm long, 3-4 cm wide. The flower is 8-9 mm in diameter. There are six sepals and six yellow petals. Berries are pink and bright red, round with a diameter of 6.3±0.04 mm. Berries ripen in a bunch of 24-38. The average weight of berries is 0.1±0.01 g; the weight of 100 berries is 14-15 g.

Seeds are light brown, greyish with strongly convex back, much smaller than those of other species. Seed length is 4.3±0.07 mm; the diameter is 3.2±0.13 mm. The weight of 1000 seeds is 11-12 g. There are 125,000 to 131,000 seeds in 1 kg.

The habitat of the species covers the Tien Shan and Pamir-Alay Ranges. The erythrocarpous barberry species differ by a greater demand for heat and lesser for moisture.

Siberian barberry (*Berberis sibirica* Pall.) was described as far back as the nineteenth century by the academician Pallas. In the wild, it is a low-growing shrub up to 1 m height with gray or brownish shoots. Leaves are leathery, oblong-ovate and not more than 2 cm long and 0.8 cm wide, awl-shaped and dentate, narrowed at the bottom and acuminate at the top. Spines are 3-5-7 partite up to 14 mm long. Flowers are yellow, solitary, 1.5-2 cm in diameter. Berries are red, broadly ovate and ripen in September. Berry length is 7-9 mm. This barberry

species is widely distributed in western and eastern Siberia, Altay and Jungar Alatau. It grows on rocky slopes, placers and rocky ground in the middle zone of mountains. It is also found in Zaysan Basin, in fine sand soil in Kazakhstan and Tarbagatay.

Kashgar barberry (*Berberis kaschgarica* Rupr.) was described by Ruprecht (Osten Sacken und Ruprext 1869) from the Tien Shan. This low-growing xerophytic shrub is 0.6-1 m height and has three separate thin yellow thorns up to 2 cm long. The leaves on perennial shoots are located in bunches with 5-10 pcs; this year shoots have 2-3 leaves. The leaves are small, 0.8-1.5 cm long and 0.3-0.5 cm wide. They are linear, broadly lanceolar. Smooth-edged leaves are rarer. Inflorescences are short and umbellate with 3-6 flowers and are large—0.6-0.8 cm in diameter. Berries are pulpy, black with a bluish bloom, small, broadly oval, 7-8 mm long, 3-4 mm in diameter and sourish. There are 3-4 seeds in the berries. They are dark brown, oblong, curved, smooth, 2-3 mm long and 1-2 mm in diameter. This species grows in northwest Tibet and the East Tien Shan.

Hawthorn barberry (*Berberis crataegina* DC) is a low-growing shrub up to 1 m in height. Branches are cylindrical, brownish-purple, bare, and thorns are up to 2 cm long. Leaves are leathery, oblong, up to 4 cm long with a clearly visible reticulated venation, smooth-edged or crenulated. Inflorescence is racemose with 10-12 flowers. Pedicles are 6-10 mm long; berries are dark purple, 8-9 mm long. This species is found in the Kopetdag as well as in Asia Minor and Iran.

Dense flowered barberry *(Berberis densiflora* Boiss*)* in the wild is a low-growing shrub. Leaves are obovate or oblong, smooth-edged or dentate. All bunches are multiflowered, sometimes containing more than 22 flowers. Pedicles are short. Berries are purple-red, 5-6 mm long. This variety grows on rocky slopes and open places in the middle zone of mountains. It is found in the Kopetdag as well as in the mountains of Iran, northeastern Turkey and southeastern Transcaucasia.

Common and Tunberg barberry are well acclimatized and successfully cultivated in Central Asian countries.

Common barberry (*Berberis vulgaris* L.) is a heavily branchy ornamental shrub, up to 3 m in height. Young shoots are reddish. Thorns are tripartite. Leaves are up to 4 cm long, ovate, of reddish color, becoming purple-red, very decorative, by autumn. The flowers are bright yellow. Berries are purple-red, 10-12 mm long, oblong-elliptical. Seeds are 4-5 mm long, brown. There are 83,300 seeds in 1 kg of seeds. Weight of 1000 seeds is 11-13 g. The common barberry is widespread in South and Central Europe, the European part of Russia and the Caucasus. Some of the decorative forms of common barberry are of interest for ornamental horticulture. These are:

1. *Berberis vulgaris* f. *atropurpurea* – with dark-purple leaves;
2. *Berberis vulgaris* f. *Macrocarpa* – with large red berries;
3. *Berberis vulgaris* f. *albo-varegata* – with white-variegated leaves;
4. *Berberis vulgaris* f. *aureo-marginata* –with golden bordered leaves.

Tunberg barberry (*Berberis thunbergii*) is a spreading shrub up to 2.5 m in height. Thorns are up to 1 cm long and thin. Leaves are 1.5 cm long, rhombic, light green at the top. There are 25 flowers in bunches; they are yellow with a reddish tint. The berries are small, red, 10 mm long and shiny. Berries remain on shrubs

until late fall. There are 5,900 berries in 1 kg. There are 88.5 thousand seeds in 1 kg. Weight of 1000 seeds is 9-17 g, The Tunberg barberry is naturally distributed in Japan and China. The following types of decorative forms are of interest for amenity planting:

1. *Berberis Thunbergii* f. *atropurpurea* – with dark-purple leaves;
2. *Berberis Thunbergii* f. *pluriflora* – multiflowered form;
3. *Berberis Thunbergii* f. *argenteo-maginata* – with a silver bordered leaves.

All barberry species, both local and introduced, are widely used by local populations. Their main value lies in their berries and roots. Valuable extracts can be produced from the berries for the food and winemaking industries.

Barberry is also valuable for forest improvement purposes in mountains. Almost all species of barberry are decorative and suitable for use in parks, orchards and public gardens. There are thus great opportunities for the barberry crop in Central Asian countries.

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BLACK CURRANT BIOENVIRONMENTAL FEATURES AND USEFUL PROPERTIES

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Black currant is a perennial shrub plant of the gooseberry family. Annual shoots grow from the base of each currant shrub, replacing old, dying branches. It is no coincidence that black currant, as the most winter-hardy crop, takes one of the first places among fruit and berry crops in the region. Black currant is widespread in the European part of Russia, Ukraine, Western and Eastern Siberia and partially in Central Asia. It grows on the banks of rivers, in and on the edges of temperate forests, in alder forests, along the edges of swamps and on wet meadows. It is widely cultivated (Pavlova 1959).

Black currant shrub has shoots of several ages. The age of shoots can be identified by the color of the cortex. Annuals are lighter, two-year shoots are a little darker, and three-year ones are even darker. Shoots that are older than three years are covered by shell bark (Yurina *et al.* 2003).

Currant is a typical shrub. The aboveground part of a shrub is composed of 20-25 branches of various ages with a height from 1 to 2.5 meters; it is regularly renewed by the annual formation of basal (zero) shoots. The number of shoots depends on the biological characteristics of the variety and plant age, but most frequently 4-5 of them are formed for a shrub (Ravkin 1987). Up to 35 leaves on an annual shoot and buds in bases of leaf are formed during the vegetation period. Buds are formed along with the appearance of the leaf layer. In most varieties, shoot buds prevail on zero shoots and it is only the upper part of the shoot where some buds become knobs in the year of emergence.

Black currant branches' main feature is the sharp decrease of annual growth both for the central axis and the side branches. Thus if a zero shoot grows 70-90 cm a year, the second year the value of growth of branches formed on its basis is 40-50 cm, and the third to fifth years only 10-20 cm. Due to the short life of fruit-bearing formations, black currant branches quickly become bare. The fruiting zone moves to the periphery of the shrub. The value of annual growth of the peripheral shrub is small, so the possibilities for producing high yields are reduced. As a rule, the most fertile are three to four year old branches—they concentrate the bulk (60-70%) of the fruit-bearing formations available on the shrub (Shalpykov & Beishenbekov 2011). Thus, black currant shrubs five to six

years old must be rejuvenated, i.e., the branches that were left to form a shrub five to six years before must be cut.

Currants start to grow at a temperature of 5-6°C, and flower at 11-14°C. The flowering phase lasts seven to eleven days. Often flowering takes place under adverse conditions (rain, wind, cold). Currant is a light-requiring plant although it can be cultivated in partial shade (Ganichkina 2000).

In Kyrgyzstan, research on the black currant has not yet been conducted. Since 2006 we have introduced the following nine varieties of black currant: Prestij, Nika, Juravushka, Poklon Borisovoy, Hercules, Lama, Cherniy Aist, Zabava and Kanakhama from the M.A. Lisavenko Research Institute of Horticulture of Siberia to conduct environmental tests.

It is planned to identify promising varieties during the introduction of black currant varieties through studying their biological, anatomical, morphological, ecological and physiological properties, followed by selection of different areas of application (processing, fresh, etc.).

In the Chu Valley ecological, physiological and biomorphological field studies of introduced varieties of the crop were conducted; the transpiration rate by means of quick weighing following Ivanov's method, leaf water retentivity follwoing Nichiporovich, real water deficiency followoing Chatskiy. At the same time, temperature and relative humidity, illumination, etc. are identified.

Work on black currant reproduction by cutting is conducted, and research is planned on the useful properties of fruits and leaves, i.e. content of physiologically and biologically active substances and their variations depending on agrotechnical practices and soil and climatic conditions.

Black currant's most distinctive characteristic is early spring awakening of buds. In the Chu Valley blackberry flowering starts in the first ten days of April and has a duration of seven to eleven days. The onset of the flowering phase depends on the characteristics of the variety and weather conditions; it can shift between six and fourteen days to an earlier or a later date.

Good preservation of flowers is one of the most important conditions for obtaining high yields of currant. Preservation of flowers and, consequently, the volume of the yield, is very much influenced by the location of the garden plot.

Currant is considered a moisture-loving plant and it is true. But it does not grow in places where the underground water level is closer than 1.5 m to the soil surface. For all kinds of currants the soil should preferably be medium-textured with acidity close to neutral (pH 6-6.5).

Currant is one of the most valuable crops. Currant berries have high content of vitamin C (up to 400 mg%), are also high in provitamin A, vitamin B, P, PP, sugar (7.7-10.2%), organic acids (2.5-4.5%), and minerals.

Of the two kinds of currants, black and red, for growing in gardens the preference is given to black currant. This is not surprising as its berries have a high content of vitamins, medicinal properties and versatility of use. Berries and leaves of black currant are used as multivitamin remedy.

At present, the use of currant for the needs of medical facilities and for filling the demand for medical products on the part of the Republic's population are covered mainly thanks to imports from abroad, which brings a high cost

for Kyrgyzstan. Meanwhile, the rich flora of Kyrgyzstan, as well as new and underutilized plants, provide many sources of raw materials for medical products.

The composition of black currant includes sugars, acids, vitamins, pectic substances and mineral salts, which is why it is called a “pantry of vitamins”. In vitamin C content, the currant excels over all domestic fruit and berry crops, being second only to rosehip and actinidia. Fifteen to twenty percent of its berries is sufficient to ensure a person’s daily need for ascorbic acid (Shalpykov & Beishenbekov 2011).

Using fresh black currant and its products is a very useful for redressing mental and physical exhaustion, fighting colds and infectious diseases, diseases of the blood vessels and countering spring vitamin deficiency in the human body. Fresh berries of black currant have antidiarrheal properties, stimulate appetite, and are used to alleviate rheumatism, ulcer disease, and anemia. Currant has diaphoretic and diuretic properties; leaves, buds and fruits of black currant have a disinfectant action associated with essential oils. Preparations from the leaves and fruits of black currant are effective against dysenteric bacilli. The leaves can serve as an early spring source of vitamins. The buds are used when necessary as a means of disinfection and a source of vitamins, even in winter. Black currant is associated with a very short dormant period; if the branch is brought to heat, the buds begin to bloom in December.

Some of the constituents of the chemical composition of black currant may prevent the development of Alzheimer’s disease. Another argument in favor of berries is made by Norwegian biologists, who believe that they contain many antioxidants that can counter cancer cells—they contain 1 000 times more such antioxidants as vitamins A, C, E and the selenium mineral than in other plants.

Leaves and fruits, and sometimes buds, are utilized. The fruits of mainly cultivated currant are conserved. Ripe fruit is conserved (July-August), being gathered in the morning after the drying of dew, or toward the evening. They are dried in a dryer, first at a temperature of 35-40° C, then finish drying at 55-60° C. They can be dried in ovens and in attics. The period of storage is up to two years (Ganichkina 2000).

Leaves are preserved in summer after fruit has ripened. They are gathered from the middle part of branches. Only leaves that are not damaged or spoiled should be gathered and this work must be done manually. It must be kept in mind that gathering leaflets can be harmful to the plant, so they must be gathered carefully. Old leaves are unfit. The leaves are dried in attics, under a tin roof or in a shed with good ventilation, being spread in a thin layer (2-3 cm) on paper or cloth (Usenko & Puchkin 2005).

The leaves are used for pickling. It should be noted that most parts of the currant yield are processed (for jams, jellies, marshmallow sticks, fillings for candies and cakes, kissel, jelly, syrup, compote, marinade). Currant is an excellent honey plant, enabling bees to produce up to 100 kg of honey per hectare (Usenko & Puchkin 2005).

Through the cultivation of currant we increase we contribute to increasing the socio-economic security and the food security of the population as well as to strengthening the health of our population.

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SUMMARY OF ALMOND ORIGIN, HABITAT AND USE IN SOUTH KYRGYZSTAN

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This article presents a summary of the origin and present habitat of different almond species and opportunities for its use in folk and official medicine as well as in other industries.

There are six almond species growing naturally in the territory of the Republic: Bukhara almond (*Amygdalus bucharica* Korsch.), spiny almond (*A. spinosissima* Bg.), common almond (*A. communis* L.), Vavilov almond (*A. vavilovii*), Petunnikov almond (*A. petunnikovii*) and Savich almond (*A. saviczi* Pachom.). In southern Kyrgyzstan they are widespread on mountain borders of the Fergana Valley and the hillsides of the Chatkal intermontaine basin.

Common and Vavilov almonds are of special value and widely cultivated. In natural phytocenosis up to 3% of common almond trees and 1% of Vavilov almond trees have fruits with a sweet kernel (Ozolin 1966), which is of great importance in breeding sweet kernel varieties and forms. The output of the kernel in these species is low—only 20% of individual Vavilov almond trees are found with fine paper and shell stones and with kernel output up to 66%.

Vavilov almond generally grows in the outskirts of Kok-Jangak town, in the Yassa river basin at an altitude of 1300-1800 m above sea level, and common almonds in the basins of the Kara-Unkur, Mayluu-Suu, Kok-Art Rivers at an altitude of 1100-1700 m above sea level. Both almond species grow in southern Kyrgyzstan in the forest-meadow-steppe zone and the zone of nut and fruit forests, tall-grass steppes and meadow steppes with shrubs, barley, sarandyz and wheatgrass steppes (Richter 1972).

In the wild, common almond (*Amygdalus communis* L.) is represented by a variety of forms, among which there are early- and late-flowering specimens with various depths and duration of winter dormancy. They vary in fruit polymorphism and resistance to adverse environmental factors. This species is the gene pool for breeding sweet-kernel varieties, although such forms are extremely rare and are mostly thick-shelled specimens, the kernel output of which varies from 25 to 30% (the maximum kernel output for this almond species is 75%).

Amygdalus, the scientific name of the genus, is attributed to the fact that the kernel contains a poisonous glucoside - amygdalin (high content in bitter almond). It is also associated with the name of the beautiful goddess Amygdalin which was

worshiped by the Phoenicians. The cultivated almond was created from its wild relatives through long-term improvement efforts. In ancient legends and literary sources of the eleventh century BC, the existence of almond in the territory of Central Asia is indicated. Its stones were found with the seeds of grapes in excavations of ancient cities and settlements of northern Tajikistan. There is no unified opinion about the centre of origin of almond. However, it is supposed that it originated in Central Asia and China.

Some researchers consider that the centre of origin of almond is in the countries of North Africa and the Caucasus, where still the wild almond can be found. Wild almond also grows in the Mediterranean region: in Syria, Lebanon, Israel and Jordan, and most probably the wild almond was cultivated in this region for the first time. Then it spread to Greece, where it was considered a symbol of fertility and various legends grew out of it.

The ancient origin of this plant is demonstrated by the mention of it in the Bible. The almond tree was associated with a cult: people decorated their houses during religious festivals, they took it with them to places of worship to the gods, used plant sprigs to drive away evil spirits from sick children. People very quickly learned to cultivate almond. As far back as the second century B.C. the Romans cultivated almond. Then people tried to grow it in France and Germany, so attractive was this plant. It did not always take root because its homeland was in more southern countries. However, almond spread to Northern Europe as a finished product. Later, in the sixth century, its cultivation began in the Crimea.

Cultivation practices of almond spread to the whole Mediterranean region, then to the USA (California), North Africa, Turkey, Iran, Australia and South Africa. Currently almond is cultivated in many countries: China, Central Asia, the Caucasus, the Crimea, the Czech Republic, Slovakia, in countries of Mediterranean region and the USA (California) (Saveleva 2011).

The almond is called the “royal nut,” as kings were the first to know and love it. In Egypt, almond was rather expensive and only pharaohs and their entourage could afford it. However, thanks to the Arabs, almond and its use in cooking subsequently came to Europe. It was added to nougat, marzipan and sauces for meat, poultry and vegetable dishes. In the twelfth century, the Italian traveler Marco Polo saw wild almond in Central Asia on the plains of Turkmenistan. Almond was the main food for travelers and merchants travelling along the Silk Road, which was used by the Chinese to bring their silk to the West. In this way it was propagated in Europe and in the territory of the Mediterranean Sea. From there it spread to Europe and the Mediterranean. Light-demanding almond trees flowered in sunny climates and soon their cultivation began, especially in Spain and Italy. To California (USA) almond trees were brought by missionaries from Spain in the middle of the seventeenth century, and now it is the largest producer of almonds in the world (Unitron 2011).

Throughout history, almond has had an important religious, ethnic or social value. Almond was the symbol of divine approval. Almond was a symbol of abundance for the newlyweds. Today, in American culture, almonds are present at weddings, symbolizing happiness, love, health, welfare and children. In Sweden, an almond is put into a Christmas cake, and the one who gets the almond slice

will have good luck in the coming year. The Romans considered almond a symbol of fertility. The Israel Cancer Association recommends fellow citizens to pay special attention to almond. A recent study conducted by scientists from the University of Montreal (Canada) showed that all nuts, and almonds in particular, are beneficial for health (INFLORA 2011).

Almond (*Prunus dulcis* or *Prunus amygdalus* or *Amygdalus communis*) is a small deciduous tree belonging to the *Prunoideae* subfamily of the *Rosaceae* family. Almond is also known as the fruit of this tree. It is classified with peach *Prunus* in the subgenus *Amygdalus*, and differs from other subgenera by its wrinkled seed coat. The kernel of sweet almond contains up to 8% water, 45-62% fat, 6% sugars, including from 0.08% to 0.58% glucose and 2.11-3.78% sucrose per dry weight, 3% gum, 6% cellulose, 4.9% ash, and up to 21.3% nitrogenous substances, of which the most part are proteins - globulin and amadin. There is abundant potassium, calcium, phosphorus, sulfur and magnesium in terms of mineral substances per 100 g of the kernel. The following vitamins are found in the kernel: thiamine, riboflavin, pantothenic acid, pyridoxine, folic acid and biotin. The main part of the kernel is non-drying fatty oil, which reaches 62%. It is composed mainly of oleic acid glyceride, and linoleic, stearic, palmitic and oleic acids.

The fruits of sweet almond varieties are used fresh as well as in the confectionery industry to produce almond oil. The shell is used in the production of brandy for coloring. Almond oil is used as an eccoprotic as well as for the preparation of ointments. Almond cake (bran) is used in cosmetics for lotions, for bathing and washing as a skin softening remedy. Bitter almond water is produced from bitter almond cake and it is used in drops and mixtures as a mild pain reliever.

Almond seed is usually 27-58% of nut weight. This is a valuable product for the medical, food and perfume industries. Up to 90% of seeds are used for food purposes. They are used for the preparation of high-quality confectionery. Sweet and bitter almond is widely used in making pastry (muffins, cakes, pies) everywhere, and in the cuisine of China and Indonesia it is added to rice dishes, poultry, meat, etc. Fried salted almonds are eaten with drinks (Saveleva 2011).

Almond seeds have soft coating, with analgesic and anticonvulsant action. In the folk medicine of Central Asia, ground seeds of sweet almonds mixed with sugar are used to counter anemia, cough, asthma, insomnia, headache, and numbness of hands or feet as well as seizures. In scientific medicine, almond emulsion obtained from seeds is prescribed as the coating, emollient and analgesic for gastro-intestinal diseases. The fruit of bitter almond is wider and shorter than the one of sweet almond, and it contains approximately 50% of the same oil as in sweet almond. Bitter almond oil is used for bronchial asthma, lung diseases, diseases of the stomach, kidneys, otitis, as well as for encouraging appetite and as a treatment for bloating and for gynecological diseases.

The almond oil “Oleum Amygdalae” is a solvent of camphor that is used for subcutaneous injections as well as to cook ointments. Almond oil is also used as a gentle laxative.

Almond contains antioxidants, especially the brown nut peel, which is the richest in antioxidants (contains flavonoids). It contains 10 times more

antioxidants than in the almond kernels themselves. Antioxidants protect cells by binding free radicals and converting them into stable chemical compounds. In order to strengthen the organism, halvah is made from sweet almond nuts and it actively contributes to the recovery of a human body from complex operations. Getter coal is made from almond shell (INFLORA 2011).

From past ages we have the results of bitter almond use by Ibn Sino, and especially his ideas on the use for hemoptysis, cough, asthma, pleurisy, kidney and bladder diseases, and to remove stones from the kidneys and bladder. In his book “The Canon of Medicine” he provides recipes where almond seeds are mentioned as a remedy that “strengthens the brain and eyesight,” “softens the body”, and “is used for cuts and sores”.

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FRUIT AND NUT FOREST CONSERVATION IN UZBEKISTAN

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The territory of the Republic of Uzbekistan, along with other Central Asian counties, is the center of origin of walnut and other fruit trees widely used in the world. The remains of extensive forests that have existed since the Tertiary period are located here and are an invaluable gene pool for breeding high-yielding varieties, the breeding and cultivation of which can significantly affect the economy of the state.

There are three areas isolated from each other in the Republic that are covered by natural habitats of nut and fruit forests and where there is the greatest distribution and diversity of nut and fruit tree species. They include: the mountainous part of Tashkent Region (ends of the Western Tien Shan Range), the northern slopes of the Nurata Range in Jizzakh Region and southern spurs of the Gissar Range in Surkhandarya Region. The largest areas of these forests are preserved in the Tashkent Region—less than 1500 hectares. They are scattered in small populations on five ranges in the lower parts of slopes and flood plains of small rivers. On the Nurata Range the remnants of these forests are preserved only in the floodplains of more than ten permanent streams in the form of gallery forests covering about 200 ha which are highly cultivated. In the South Gissar, nut and fruit forests cover only the area of about 50 ha in the basins of the Sangardak and Tupalang Rivers, represented by small units on the lower slopes among maple and ash forests and xerophytic shrub.

In the wild, walnut can successfully grow and develop under conditions found in Uzbekistan with an average amount of precipitation of 800 mm per year. Such conditions are found in the Republic only in the Western Tien Shan. In two other areas, annual rainfall is less—in the South Gissar at 700 mm, and in Nurata not more than 500 mm. In these circumstances, walnut is preserved in the ancient habitats only in mountain river valleys with close groundwater forming so-called gallery forests. Such forests are formed on the Nurata Range and in the Western Tien Shan along with the ones found on slopes. Walnut successfully grows and develops on deep skeletonless soils that form the so-called dark-brown soils of nut forests characterized by high fertility. But with sufficient soil moisture, walnut grows well on rocky soils, and tali, and in floodplains on undeveloped soils.

The height of the nut forest range is from 800 to 1800 m above sea level in the northern part of habitat and up to 2300 (2800) m in the southern part. Low air temperature is a factor limiting growth above these boundaries.

Nut and fruit forests are the part of the rich plant community, including more than 1000 species of higher plants, where nut trees cover mostly the slopes of northern directions in the first tier of the forests. The second tier includes many species of fruit trees and shrubs. Fruit trees include apple (*Malus*), pear (*Pyrus*), mahaleb (*Cerasus*), alycha (*Prunus*), hawthorns (*Crataegus*), hackberry (*Celtis*) and oleaster (*Elaeagnus*); fruit shrubs include rosehips (Rosa), barberries (*Berberis*), cotoneaster (Cotoneaster), buckthorn (*Rhamnus*), etc. as well as non-fruit species of trees such as maple (*Acer*), poplar (*Populus*), tree-juniper (*Juniperus*) and willow (*Salix*). Meadow, meadow-forest, meadow-steppe and steppe grass stand are associated with rich species composition, and an air-dry biomass of 15-30 quintal per ha are developed on cleared plots.

In addition, nut forests are home to many animals and birds that feed on fruit products of these forests and whose lives depend on the forest conditions. Animals also actively affect forest life, taking part in the distribution of seeds, the formation of typical forest soils, helping in the fight against pests, etc. Eradication or displacement of these animals from forest areas by man does irreparable damage to nut and fruit forests.

Since walnut trees grow in Uzbekistan under very harsh climatic conditions, any adverse impact on any component of the specific nut tree biocenoses will affect the survival rate for all nut trees. First of all this impact disrupts the process of natural regeneration of nut trees because at early stages of development any organism is most vulnerable to stress environmental factors, or other violations of the conditions of growth. In addition, these violations lead to a weakening of the nut tree's resistance to adverse factors such as attacks of pests and diseases, droughts and frosts. As a result, competitiveness of the nut forest reduces and the areas it is excluded from due to the reasons mentioned above are occupied by other species better adapted to the environment, such as Turkestan hawthorn, alycha, buckthorn, cotoneaster and rosehip. Thus nut forests are often replaced with impassable spiny thickets of trees and shrubs. In areas where cattle of the local population graze intensively and do not allow any vegetation to grow, nut forests are replaced with poor steppe phytocenoses with weak projective cover of grass stands and active water erosion of soil.

Walnut in forests is characterized by immense form diversity. Almost every tree differs from the others for some reasons. Trees of different height and habitat are distinguished by the crown, stem shape, the nature of the branching, crown density, size, color, shape and structure of leaves, fruit quality, resistance to drought, pests and diseases, phenological stages onset timings, etc. There is an unlimited set of genetic material that can be used in breeding new varieties.

The surveys showed that the local population was not familiar with methods of vegetative reproduction of walnut and, therefore, cannot create clone varieties of the best economically valuable forms found in the forests. The practice of directly transferring these forms from forests is also impossible as in the forest the nut begins to bear fruits later when tree size is too large to be transplanted

to a new location. Reproduction of the best forms using seeds does not lead to success because of the great segregation of hereditary traits. This is related to a large number of nut trees with poor or mediocre quality of the fruit located in settlements adjacent to nut forests. For that reason, nut forests are the sole source of unlimited walnut gene pool, which makes them even more valuable.

Almost all these forests are attributed to the State Forest Fund. A large number of people live in close proximity to these forests and because of that the forests are suffering a strong anthropogenic pressure, mainly due to overgrazing of livestock, full harvesting of both nut and fruit trees, as well as cutting for firewood, and are rapidly being destroyed. The loss of every tree in the forest impoverishes the gene pool. Observations made in nut and fruit forests within the framework of the GEF "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and their wild relatives) in Central Asia" project supported by UNEP and coordinated by Bioversity Internmational showed a complete absence of natural replenishment of walnut and other fruit species that are wild relatives to cultivated plants as well as a strong depletion of the phytocenotic composition of plantings and habitat destruction.

Nut and fruit forests are divided into four groups based on their preservation status: well-preserved where nut trees are the main forest-forming species, forests where nut trees are present but not more than three to four taxonomic units; forests where nut trees are excluded from the composition and replaced by other fruit species, and finally, areas that came out of nut forest due to its complete destruction, which formed open steppe spaces.

The following main activities are recommended to preserve and recover nut and fruit forests:

- In the forests of the first group: a total ban on grazing, especially unregulated grazing; harvesting nut and fruit trees at no more than 60% of the annually determined harvest; selective sanitary cuttings only for dead tree disposal; only biological control measures for pest and diseases control; prevention of unauthorized tree felling; carrying out other forest management activities on the scale set by forest management.
- In the forests of the second group: except for the activities mentioned above, we recommend seeding or planting of seedlings of walnut on sites or in holes under forest canopy from seeds of an ordinary mixture of seeds from the local population to preserve the gene pool; for improvement cutting purposes, use of thinning of related species that prevent the growth of walnut is recommended.
- In the forests of the third group where nut is not present in the composition, seeding or planting of seedlings of from local walnut populations on sites under the canopy of trees in areas with favorable growth conditions for nut trees; after obtaining reliable nut undergrowth, carry out a clearing of existing plantations in locations of walnut undergrowth; on the slopes of southern exposures under crop canopy, create more xerophytic species—apple, almond, alycha, etc.,—in accordance with their environment;
- On steppe slopes favorable for growth of walnut and other fruit trees, create mixed forest nut crops with wild fruit trees and shrub species which enter

the composition of fruit and nut forests as well as from the gene pool of local populations according to existing recommendations.

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POMEGRANATE DISTRIBUTION AND DIVERSITY IN UZBEKISTAN

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Uzbekistan has long been famous for its high quality of fresh and dried fruits and grapes. During recent years, sub-tropical fruit crops have been outstanding in terms of valuable nutrients, dietary, medicinal and other properties of fresh fruits. In addition, their processing products have been extensively developed.

Pomegranate is the most widely produced crop among sub-tropical fruit trees cultivated in Uzbekistan. The northern boundary of its habitat crosses the entire territory of the Republic. Extreme boundary conditions significantly affect the growth characteristics of the annual cycle of pomegranate development; this determines the character of methods used in its cultivation.

Research on the pomegranate crop in Uzbekistan was carried out by B.S. Rozanov (1976), V.V. Kuznetsov (1971), O.P. Kulkov (1983), U. Saidaliev (1969), S.A. Seredkin (1977), A.K. Sokolov (1960) and others.

Pomegranate is referred to the *Punicaceae* family that has only one genus, *Punica,* which includes two species: *P. protopunica* Balf. and *P. granatum* L. Species *P. protopunica* Balf. is endemic to the island of Sokotra (Indian Ocean), the flora of which is characterized by an abundance of relict species that only grow there.

N.I. Vavilov considered that early cultivation of pomegranate occurred in the West Asian center of origin of cultivated plants, which includes Asia Minor, the Caucasus, Iran and the mountainous regions of Turkmenistan (Vavilov 1960). These are the areas where wild relatives of pomegranate and the richest diversity of its cultivated forms are concentrated.

The *P. granatum* L. species is represented by cultivated and wild forms. In natural growth conditions pomegranate is a small tree or large shrub up to 3-5 m height with a curved trunk and a heavily branched crown.

B.S. Rozanov developed an intraspecific classification of fruit forms of pomegranate that covers the existing varieties within the crop and provides insight into the phylogenesis of *Punica granatum* L. species. Within *P. granatum* L., two subspecies are distinguished: 1) Subsp.*chlorocarpa* B.R. - with green

ovary with two varieties: *var. viridicolla* B.R. (green collar) and *var. rosaeicolla* B.R. (pink collar); 2) Subsp.*porphyrocarpa* B.R., with red ovary with two varieties: *var. rubricolla* B.R. (red collar) and *var. cinereicolla* B.R. (bluish collar).

Most of the widespread cultivated pomegranate varieties are bluish collar and red collar varieties of red ovary subspecies. The red collar variety of red ovary subspecies includes Kzyl-anor, Surh-anor, Bala-myursal, Gyulosha rozovaya and Krmyzy-kabuh varieties; the bluish collar varieties include Kazake-anor and Shah-nar. Green collar varieties of green ovary subspecies include Baysun, Bedona dashnabadskaya, Shoulyansky and Zyubeyda; the pink collar varieties include Achik-dona, Ak-dona and Kzyl-dona.

Uzbekistan is well-prepared for wintering pomegranate plants—annual shoots are damaged at 14-15°C subzero, perennial branches at 16-17°C subzero and the aerial part of the shrub at 18-19°C subzero. The survey found that different varieties of pomegranate are unequal in terms of vulnerability to frost. Thus, within krasnozavyaznogo subspecies, which includes most of the cultivated varieties, the sizosheykovoy varieties of plants suffer from frost 1.5-2.0 times less than the krasnosheykovoy variety. The survey showed that pomegranate varieties of various forms have different frost resistance. Thus, within red ovary subspecies, which includes most of the cultivated varieties, plants of bluish collar form are damaged 1.5-2.0 times less than those of red collar. The increased frost resistance of the bluish collar form is consistent with the characteristics of its evolution and its later emergence within the *P. granatum* L. species. Kazake-anor and Bashkalinsky are varieties of increased resistance; and Achik-dona of low resistance.

Pomegranate grows on different soils, from sand and shingle to heavy clay, but the best fruits are produced on deep, water-absorbing and fertile loamy soil with good drainage.

Pomegranate flowers at an average daily temperature of 20ºC. Pomegranate pollen begins to germinate at 12ºC and 20-25ºC, which is optimum.

In northern Uzbekistan in Tashkent Region, pomegranate budding is observed in mid-April, flowering from 15-25 May to 20-25 June, yellowing of leaves in mid-Septembe while the period from the beginning of vegetation to fruit harvest takes 170-180 days, from flowering to harvesting 130-150 days. The period between breaking of buds and beginning of flowering in case of plants of red collar variety is longer than that of the bluish collar variety, which indicates that there are certain biological differences between them.

Varieties of other pomegranate forms have no significant differences in phenological stages. Variation of timing of their occurrence is within the limits characteristic for the red ovary subspecies.

Pomegranate is distributed on irrigated lands of the Fergana Valley and on the slopes of surrounding mountains at an altitude of 360-1400 m, more often at 360-800 m, and in the south of the Republic in Surkhandarya Region at 300-1400 m. Pomegranate plants are the most productive up to an altitude of 1000 (1200) m.

Pomegranate plantations in Uzbekistan are concentrated in several areas representing the main loci of this crop. The Namangan group of areas in the Ferghana Valley is located in the piedmont zone of the southern slopes of the

Chatkal range. The main local varieties are Ak-dona and Kay-achik-anor. The large-fruited variety Ak-dona is found and it is referred to as Tuya-Tish, and Achik-dona or Obik-anor in admixtures.

In the Kuva group of areas of the Fergana valley, Achik-dona is the main variety in plantations, where admixtures of Kay-achik-anor and Chuchuk-dona are encountered.

The Andijan group of areas occupies an intermediate position between the previous two. Local varieties are Achik-dona, Kay-achik-anor, Ak-dona, and Kai-shirin-anor in admixture.

The Denau group of areas is located in the northern part of Surkhandarya Region. The largest of the old plantations are located in Dashnabad village and are represented by Kazake-anor and Kzyl-anor varieties.

The Sherabad group is in the southernmost, warmest areas of Uzbekistan. The following varieties are found here: Kazake-anor, Kzyl-anor, Sherabad kisliy, Sherabad sladkiy, Nordon pashkhurdsky.

The Kitab-Shakhrisabs group of areas of the Kashkadarya Region are represented by large old pomegranate plantations located in Varganza and Shatry villages. Mainly Shirin-anor, Bedona Varganzinskaya, Ulfi sweet varieties are cultivated, and the spicy and sour variety Achik-anor is found.

In conclusion, it should be noted that pomegranate is a highly profitable crop. Demand for pomegranate and its products is constantly growing. The most important thing is that, unlike other fruit trees, in all areas of its cultivation the collection consists mainly of local varieties of traditional breeding. This indicates that they are not at risk of extinction.

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WILD SEA-BUCKTHORN IN KYRGYZSTAN

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The article provides data on the natural distribution of sea buckthorn in Kyrgyzstan as well as forms identified during research and their morphological characteristics.

Recently, many research activities have been devoted to the study of polymorphism, biochemical composition, sea buckthorn resources and distribution of this species in the territory of the CIS countries. Despite rather wide distribution of sea buckthorn in Kyrgyzstan, it is very poorly studied. Z.Kh. Sarymsakov's monograph "Sea buckthorn in southern Kyrgyzstan" (2004) must be noted among the works of recent years; the author was first in the Southern Kyrgyz Republic to cover issues of species phytocoenology and provides the characteristics of the main formations and associations of sea buckthorn, including biomorphological characteristics of 43 forms of local sea buckthorn populations identified by him.

Sea buckthorn is found everywhere in Kyrgyzstan: Issyk-Kul, Kochkor, Chu, Talas, Suusamyr, Ketmentyube, At-Bashi and other valleys, in the floodplains of major rivers and other small rivers and says. In Kyrgyzstan, sea buckthorn grows up to the altitude of 3100 m above sea level.

On a national level, resolution of the problem of rational use and reproduction of plant raw material with the assistance of the GEF "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia" project supported by UNEP and coordinated by Bioversity International contributes to the conservation of local varieties and forms of fruit crops and their wild relatives. Studies conducted within the framework of the project on pilot sites of sea buckthorn habitat (Issyk-Kul and Naryn Regions) showed great form diversity. Five plus trees that differ in morphological characteristics (size, color of fruit, stem length, prickliness, etc.) were identified. Studies revealed that population density of sea buckthorn in Issyk-Kul basin is on average 80-90 shrubs per hectare, of which female specimens make up only 35%. The average yield per shrub ranges from 2.1 to 2.5 kg of fruit; the weight of 100 fruits from 19 to 23 g. Fruit stem length also varies considerably from 2 to 3.2 mm.

Studies revealed that plant height, depending on soil and climatic conditions, varies greatly—from 2.4 to 5.5 m. Prickliness ranges from 3 to 4 points on 5-point scale. The length of lamina varies from 4 to 5.9 mm, width from 4 to 6 mm. Fruits

are mostly yellow-orange and orange, the taste is either sour or sweet and sour, shape is globular and egg-shaped, and fruit length varies from 6 to 9 mm at a width of 5-8 mm.

Most people in the regions under study use sea buckthorn for food and medicinal purposes. In Naryn Region people use sea buckthorn as also as firewood. Sea buckthorn fruits are the source of additional revenue for many people in Issyk-Kul and Naryn Regions. The plant is extremely valuable: leaves, cortex, fruits, seeds are used in medicine, different foodstuff are produced from fruits, and they are the raw material for winemaking. The plant is widely used as steppe and field-protective forestation as well as landscape gardening. Currently, in the Issyk-Kul and Naryn Valleys, the condition of sea buckthorn natural populations is generally poor.

Sea buckthorn has long occupied a huge area along the coast of Lake Issyk-Kul and in the floodplains of large and small rivers in the region. For many years, sea buckthorn forests were the responsibility of no one and thus unprotected, and consequently the area occupied by them has reduced in size, which has led to the extinction of habitat of plants and animals and disruption of lacustrine ecosystems as a whole. The main threats to sea buckthorn populations are extensive grazing, haying and destruction of native vegetation during expansion of park and beach area of the lake, as well as unauthorized felling of sea buckthorn trees in the floodplains of the major rivers of Tup and Djergalan.

According to A.T. Djumadylov (2010) buckthorn flowers in April and May, somewhat earlier or simultaneously with foliage expansion. Flowering period duration is 7-10 days depending on weather conditions of the year. Pollination is by wind. Fruits ripen in late August and September. In the wild, sea buckthorn reproduces both by seeds and vegetatively—root shoots, offset, root and stem cuttings. With seed reproduction, seedlings appear in May.

As Tkachenko and Andreichenko (1996) mentioned, sea buckthorn thickets in Kyrgyzstan are gradually disappearing as a result of human impact on them (cutting, fires, overgrazing, gravel and sand recovery, establishment of rice bays, grasslands and lands for agricultural crops, etc.). Large thickets of sea buckthorn were destroyed on the lakeside of Issyk-Kul Lake during the building of boarding houses, holiday houses and recreational camps. In some districts the area of riparian cenoses with sea buckthorn has decreased by 30-50%.

In our opinion and the opinion of other researchers (Jumadylov 2010) forms should be distinguished: by shape of the crown (tree, shrub, and climbing vine), by fruit size and weight (small-fruited, medium-fruited, and large-fruited), by fruit shape (round, oval, cylindrical, ovoid, barrel, and other intermediate forms), by fruit color (orange, yellow, red and other intermediate colors) and spiny and non-spiny forms.

Today, according to the National Forest Policy of Kyrgyzstan and the Concept of Forestry Development, in the near future forests of the Republic should follow the path of integrated development. In addition to solving major forestry problems (so-called “collateral use of the forest”), wild fruits, nuts, medicinal and industrial plant stocking has become critically important. There is a marked need for health facilities and for drugs, currently covered mainly by imports from abroad and

thus quite expensive. Meanwhile, the rich flora of Kyrgyzstan, including new and underutilized plants such as sea buckthorn, can provide the raw material source for many medicines.

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FRUIT CROP GENE POOL CONSERVATION IN ZARAFSHAN RESERVE

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Recently, anthropogenic pressure has caused significant changes in the composition, distribution and quantity of fruit trees that are exposed to human impact in economic activity. Harvesting, tree felling, grazing, fires, removal of gravel, all have negative impact on plants. Conservation of species diversity will enrich the gene pool of fruit trees and will allow them to be used in the national economy (Sarimsakov 2004).

A wide variety of fruit species wild relatives grow in the wild flora of Central Asia. They are preserved in natural habitats, are notable for high intraspecific diversity and are a constant source of replenishment of the gene pool of cultivated plants with valuable germplasm, as well as a secure gene bank for future breeding (Panteleeva 2006, Plekhanova 1988).

Most species of wild plants were widely used in the past and are currently still in use, resulting in a decrease in their genetic resources and, in some cases, to their complete extinction (Temirbaev 1969, Tukhtaev *et al.* 2003). For centuries, with accounts of conditions of extreme continental climate in Uzbekistan, traditional breeding has produced varieties and forms of fruit crops that are adapted to the specific environmental conditions.

Conservation of local varieties and forms of fruit crops and their wild relatives is important for environmental protection, the national economy and the stability of agricultural production. And in this respect protected natural areas are very important. Among them, Zarafshan State Reserve, located along the right channel of the Zarafshan River, is of particular importance. Mainly riparian vegetation, represented by trees, shrubs and herbaceous plants grows here.

Among the biodiversity of the reserve, a special role is played by wild fruit crops, which occupy a significant part of the area under forest vegetation. In the reserve of wild fruit plants, which are of great scientific and practical importance, the most common are sea buckthorn (*Hippophae rhamnoides* L.), smooth-edged barberry (*Berberis integerrima* Rgl.), Turkestan hawthorn (*Crataegus turkestanica* Borkh.), Eastern plum (alycha) (*Prunus sogdiana* Vass.in), European dewberry (*Rubus caesius* L.), wild rose (*Rosa canina* L.) and Russian olive (*Elaeagnus angustifolia* L.).

For several years, comprehensive studies of the sea buckthorn—a valuable nutritional, medicinal and ornamental plant – and other riparian plants have been

carried out in the reserve. Sea buckthorn occurs as trees or shrubs and forms clumps of different sizes. Plants reach 3-6 m in height. Extensive thickets spread along the Zarafshan River. Thanks to seed reproduction, sea buckthorn can be found in riparian thickets as individual specimens at some distance from the river. In the reserve sea buckthorn is present in various forms that differ in size, fruit color and plant prickliness. Xanthocarpous, orange-fruited and red-fruited forms are considered widespread. Mildly-spiny forms that are of great interest for breeding are found in the thickets.

The study of seed and vegetative reproduction showed that seed germination is 50-60%, and the rooting of cuttings at 70%. Given that in seed reproduction the male to female ratio is 1:1, we recommend reproduction by cuttings to conserve the gene pool of unique forms of sea buckthorn. Due to the selection of unique forms of sea buckthorn from its natural population, we have created a field collection of plants which can be used in further breeding work.

Another species with potential for use in species introduction is growing in the reserve—smooth-edged barberry, which has a number of uses as a nutritional, medicinal, ornamental, dye and honey plant. It is found everywhere in the forest zone of the reserve and due to its drought resistance and shade tolerance, it occurs as a shrub up to 3 m in height in a great variety of forms. There are shrubs with varying degrees of prickliness with red, burgundy, lilac and purple-black fruits. The seed and vegetative reproduction of this species were studied. Rooting of cuttings was very low and did not give positive results, and seed germination was 70-80%. Therefore, we recommend the seed reproduction method for the crop. From the wild population we selected seeds of different plant forms, which were planted in open ground and formed the basis for the creation of field collections for further work.

In addition to the above mentioned species of fruit plants, Turkestan hawthorn, used for food, medicine, honey, and ornament, also grows in the reserve. Throughout the forest zone of the reserve, alycha is widely distributed, mainly found in old orchards and forms fruit of various shapes and colors—there are forms with yellow, burgundy and purple-black fruit.

Wild rose is also widespread—a valuable shrub that is common in the reserve due to its drought resistance and shade tolerance. European dewberry is extensively distributed along channels and creeks of the reserve. Russian olive is also a promising area of research for subsequent introduction of the crop into cultivation. Being a salt tolerant and drought resistant species, it is distributed in all parts of the reserve and creates a large number of forms different in size, shape and color of the fruits.

The flora of the Zarafshan reserve is thus a unique complex of natural plant biodiversity in this region, the gene pool of which can be used for further breeding. Our studies show that due to the classical selection of plants from natural populations, breeding forms with a complex of unique traits and suitable for economic use can be created.

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ASSESSMENT OF THE RESULTS OF THE UNEP-GEF/ BIOVERSITY INTERNATIONAL PROJECT «*IN SITU*/On farm CONSERVATION AND USE OF AGROBIODIVERSITY (FRUIT CROPS AND WILD FRUIT SPECIES) IN CENTRAL ASIA» IN UZBEKISTAN

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Uzbekistan is homeland to many species of fruit trees and grape which have provided men with food for many centuries. Due to this, many local varieties of fruit tree species of these plants were bred here and in other Central Asian Republics. Today, the role of local varieties of fruit crops and their wild relatives, which are the repository of unique gene pools used for breeding new varieties becomes more important. Recently not only the erosion of local cultivars of fruit species, but also extinction of their wild relatives has been observed in Uzbekistan. The loss of these species with their rich gene pool will be irreversible, and therefore the conservation is one of the most important tasks in the country.

The Uzbekistan component of this GEF project "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and their wild relatives) in Central Asia" is aimed at the conservation of the gene pool of eight fruit species which are of high priority for the country—apple, pear, apricot, grape, walnut, almond, pistachio and pomegranate. The project developed the basic gene pool conservation techniques for local varieties and forms both on farm and in the wild stands (*in situ*). This is implemented in cooperation with farmers and leaseholders of forests by creating orchards with these local varieties of fruit trees and growing seedlings for sale to the population, as well as conservation of wild stands of wild fruit species with the highest amount of diversity. For this purpose, five groups of experts and researchers were established by the project and they were assigned a task of searching for and inventorying endangered local varieties of the eight fruit species. The entire territory of the Republic was divided among the five groups representing various research institutes.

During field surveys, 22 demonstration plots with a total area of 13.9 ha with local varieties and forms of fruit crops and their wild relatives were established in selected agroecological zones based on farm enterprises and forests. It was determined that 100 local varieties and forms of target crops grow at these sites, including: 17 local varieties and forms of apple, 28 of apricot, 12 of pear, 24 of grape, 13 of pomegranate, one almond form, three walnut forms, two pistachio

forms. Three demonstration siteswere created for wild apple, walnut and pistachio wild populations.

In addition, 17 key nurseries were selected and developed during the expedition. These nurseries were provided with grafting material of 22 local varieties and forms of apple, 25 of apricot, 8 of pears, 22 of grape, 14 of pomegranate, 4 of almond and 4 of walnut. Produced plant materials of target fruit crops were distributed among and sold to farmers of the Republic. Expert scientists found 264 local varieties and forms of the above mentioned fruit species in the Republic. Having reviewed their quality indicators, we recommended about 150 varieties and forms for reproduction.

The survey found farmers and local people who grow the best local varieties of fruit trees and promising forms of wild relatives. The data collected on these farmers, their contacts and local varieties are listed in an Excel spreadsheet. Based on these data, the Register of local varieties of target fruit crops and was developed and prepared for publication.

Materials on the traditional knowledge of farmers on cultivation of fruit crops, drying and their fruit preservation were collected during the expedition. On the basis of these data, a brochure on traditional knowledge of farmers was developed and is being prepared for publication.

Eleven recommendations on the cultivation of local varieties of fruit crops were developed and published in order to provide assistance to farmers. Educational materials on marketing, agricultural accounting and “molecular markers,” as well as eight booklets, five posters and one calendar, as well as newspaper and magazine articles, were prepared and published. To analyze and discuss the status of the issue, one international and one national conference of young scientists, two press conferences in the national press center, and two media tours with representatives of the media were held. In addition, appearances on television and radio were organized.

A proposal on the development of horticulture and viticulture in the Republic was presented to the Government. In nine regions of the Republic, ten multi-functional local committees were established by the project; they are comprised of representatives from the district *khokimiyats*, departments of agriculture and water resources, forestry, farmers’ associations and agricultural companies, chairmen of *mahalla* committees and several key farmers. In order to coordinate their activities steering committees were organized.

As a result of the project activity more than 300 farmers were trained on the collection of local fruit species, farming techniques of their cultivation, pest and disease control, new technologies, marketing, accounting and record-keeping, the benefits of cultivation of local varieties and forms of fruit crops. Strengthening linkages between farmers was carried out through participation in exhibitions of agricultural products where farmers’ achievements were shown. Due to joint expeditions, participation in trainings and workshoops, and meetings held by the national project implementation unit, strengthening of linkages between institutions in the Republic is observed.

During the project implementation period, farmers and local communities’ capacities in the conservation of traditional local varieties of fruit trees and their

wild relatives have improved. For this purpose, tactics were designed to support farmers' and local communities' *in situ*/on farm activities as farmers are the central figure in this matter and their participation is the determining factor in achieving conservation *in situ*. Therefore, a strategy for management of local varieties of fruit trees was developed in cooperation with farmers. The level of farmers' knowledge and experience in managing agroecosystems has improved.

As a result of the project development the following activities were carried out:

1. Development of proposals for decision-makers to support farmers and the public in conservation of local varieties and their wild relatives.
2. Improvement of knowledge, experience, methodologies of conservation, cultivation, processing, storage of local varieties of fruit crops and products of their wild relatives.
3. Conservation and efficient use of the genetic diversity of fruit crops and their wild relatives in Uzbekistan.
4. Distribution of genetic diversity of fruit crops and increased knowledge about the value of this diversity for agriculture and healthy ecosystems.
5. Development of proposals to support farmers, local communities and conservation of fruit species and their wild relatives' gene pool in Uzbekistan and submission to legislative authorities.

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Annual technical report for 2010 of the GEF Project «*In situ*/On farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia» (component Uzbekistan) supported by UNEP and coordinated by Bioversity International. Tashkent, 2010.

Annual technical report for 2011 of the GEF Project «*In situ*/On farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia» (component Uzbekistan) supported by UNEP and coordinated by Bioversity International. Tashkent. 2011.

INFORMATIONAL POTENTIAL OF FRUIT CROPS GENE POOLS IN TURKMENISTAN

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More than 40 species of wild relatives of fruit crops of the Central Asian genetic center of origin have been preserved in the wild (*in situ*) in the mountainous regions of Turkmenistan (*Kopetdag, Koytendag, Great and Small Balkhans and Badkhyz*). They began to be domesticated several thousand years B.C. Wild relatives and ancient varieties of fruit crops in Turkmenistan show a wide range of adaptations to different natural stresses, which is of great importance in the context of global climate shifts. During the domestication process, local communities selected genotypes most resistant to diseases and pests and well adapted to local environmental conditions. These genotypes are actively sought in today's world as the carriers of unique germplasm.

In *ex-situ* conditions in the Mahtumkuli Research and Production Development Center (MRPDC) of the Institute of Botany of the Academy of Sciences of Turkmenistan, a collection of this unique genepool of fruit crops was established as early as 1935. By the beginning of the twenty-first century, an inventory showed the following results in 2004: the collection included 1648 conserved genotype accessions, of which 890 are of pomegranate, 137 of apple, 34 of pear, 13 of plum, 92 of fig, 33 of pistachio, 30 of almond and 419 accessions are of grape. Of 220 wild accessions in the collection, ancient and local varieties are represented by 142 accessions of eight crops, which overall accounted for 22% of the total quantity. Almost all of these species are included in the international IUCN Red List (2007). An expense-based cost of MRPDC collection exceeded 40 million USD. All this rich gene pool can be used by local farmers for their individual breeding on the basis of special agreements between farmers and MRPDC.

Natural populations of the relict common pomegranate (*Punica granatum*) are presented in the canyons of the southwest Kopetdag by a wide variety of high-yielding large-fruited forms, notable for resistance to pests, diseases, deadwoods and frosts. Its fruits can be sour and sweet, small and large, early and late, and are important for use in breeding. In total, the trees number 15,000-20,000.

There are 890 accessions in the live pomegranate collection (*ex situ*) of MRPDC; its core includes 94 forms which are assigned to various natural populations growing in the wild in Turkmenistan, and 42 varieties (*cultivars*) derived from the pomegranate germplasm of Turkmen origin. Accession of the following ancient varieties have been preserved in the collection: *Parfyanka, Turan, Sumbar, Molla*

Nepes, Nissa, Kemine, Messarian, Sogdiana, Girkanets, Ariana, Dakhistan, Zelili, all of which are still cultivated by farmers in their orchards (Levin 2001).

Turkmen apple is an endemic subspecies of Asian wild apple (*Malus sieversii* ssp. *turkmenorum* Juz), wild forms of which were cultivated in the West Kopetdag even in the fifth and fourth centuries B.C. Ancient local varieties (*Turush, Okcha, Yuvan, Adji, Ahlamad Yazgi, Surkhak, Kizildja, Shaker, Syuydji*, etc.) are known collectively as "babaarabian" apple. The Kopetdag wild apple tree is found as individual trees or in small groves. Samples differ in fruit color and degree of pigmentation of branches; they are highly heat resistant and drought resistant.

The variability of wild apple and discovery of forms close to the local cultivated apple, in some cases gave rise to doubts about its "wildness". Turkmen apple is of no great value as a fruit species in the horticulture of Turkmenistan and its fruits are not of high quality, although some specimens have quite sweet and aromatic fruits. Turkmen apple rootstock is capable of forming resistance to diseases and pests in cultivated plants. The MRPDC collection includes 31 wild apple specimen and 36 local varieties, including seven ancient varieties. Apple fruits are small or medium-sized, round or flat-round, greenish-yellow, yellow with a blush. The pulp is white or cream and of sour, sour-sweet or sweet taste (Ponomarenko 1990).

In the canyons of the Southwest Kopetdag the common pear (*Pyrus communis*), Turkmen pear (*P. turcomanica*) and Boissier's pear (*P. boissieriana*) occur in groups and in small groves. The total population is less than 500 individuals that are of value as a drought-resistant rootstock for cultivated varieties. Thirty-four accessions are preserved in the MRPDC collection, 15 of which are wild and two local varieties (Gorelde and Vannovsky). The fruits are small, yellow or green and sour or sweet-sour.

Of *Prunus* genus or plum, the following varieties grow in the wild in the gorges of the Southwest and Central Kopetdag: common plum (*Prunus domestica* L.) and alycha plum (*Pr. cerasifera*), occurring here in the undergrowth of nut and deciduous shrubs. The geographical isolation of the West Kopetdag alycha on the edge of habitat and its distinctive morphological features allow us to attribute it to the form *Prunus cerasifera* subsp*. turcomanica* (Lunaeva 1984). Kopetdag alycha plum is still underestimated and is found in small quantities. Forms vary in shape and color, with small fruits prevailing that are round or oval, yellow, red and sometimes almost black. Alycha fruits have a particularly rich range of eating flavors with many flavors that are associated with the taste of other fruits, including exotic ones. Alycha is notable for being undemanding with regard to soil conditions, it withstands salinity, is very drought-resistant, is resistant to diseases, is not damaged by aphides and is well-crossed with plums of American and European origin. That is why breeders consider alycha the most valuable of all plum species occurring in the wild. Moreover, researchers have arrived at the conclusion that the alycha plum is able to cross with representatives of close genera and give fertile offspring, forming spontaneous hybrids. Recommended collections often include selected forms of alycha rather than distinct species. In the MRPDC collection alycha is represented by 13 breeding industrial table species (including *Turkmen, Kok sultan, Karakalinsky, Marmeladniy 4, Vengerka Turkmenskaya* and *Konditerskiy*.

One of the oldest plants of Turkmenistan is wild common fig (*Ficus carica*); it is found in almost all the Kopetdag gorges, forming broken thickets. The local population has recently introduced local varieties of fig into cultivation from a wild state. Anisophylly (alternation of whole and dissected leaves) and a double-lobed leaves are typical, which is a sign of hybrid origin. The fig trees fruit twice a year; their color varies from creamy yellow to brown-spotted, red-purple and even dark blue and black-purple.

Winter resistance of fig varies depending on variety (form), age and environmental conditions. Once in two to three years, fig suffers from winter frosts in the dry subtropical zone of southwest Kopetdag, once every four years from frosts. The fig collection in MRPDC is represented by 92 accessions, 15 of which are varieties of traditional breeding (*Shevlansky, Nokhursky, Koynekasyrsky jeltoplodniy, Chikishlyarsky krupnoplodniy, Kukurchinsky melkoplodniy, Kurujdeysky jeltoplodniy*) and six wild accessions (Levina 1982).

Pistachio (*Pistacia vera*) is a relict forest fruit crop of the Miocene age. Wild forms of pistachio of the Kopetdag, Badkhyz and Koytendag are the “green gold” of the country that is of exceptional value for dry gardening in Turkmenistan and for forming arrays of orchard nut crops. It is characterized by a strong variation in traits of nut fruits and leaves, as well as low polymorphism of fruits with poor crackability of their fruits and resistance to pests, diseases, and hot dry winds. The total area of natural pistachio woodlands in Turkmenistan primarily of the ephemeral type does not exceed 80 thousand ha. The gene pool of the mother collection of MRPDC is represented by 33 samples, 15 of which are wild accessions of Turkmen origin, mainly from Badkhyz. Tajik and Azeri accessions of pistachio have already dropped out of the collection (Popov 1978).

Isolated populations of wild common almond (*Amygdalus communis*), the ancestor of cultivated varieties of almond, are found in the southwest Kopetdag. The domestication of common almond was based on the selection of forms with sweet seeds. The studies of polymorphism in local populations of almond are of practical importance in the identification of valuable mutations to fix them in the accessions. MRPDC includes 18 wild and eight local forms: *Karakalinsky rozoviy, Karakalinsky 30, Turkmenskiy otlichniy, Turkmenskiy urojayniy*, etc.

Wild grape (*Vitis sylvestris*) and remains of cultivated grape (*V. vinifera*) formed a great variety of forms in the canyons of the Southwest Kopetdag during the process of natural and artificial breeding (Nosulchak 1984). In some valleys of the central Kopet Dagh, wild vines of cultivated type have survived, and very rarely vines with a male flower, which indicates habitation of true wild grape representatives in this location. The original form of ancient grape varieties (bunch length up to 61 cm) was found in the Bakhchi Gorge in Akbugday ditrict (formerly Gyaur district) (Nosulchak 2009, Petrova 1979). The morphogenesis process of wild grape is still in progress today. Therefore, some cultivars carry many of the properties of wild grape (e.g, *Irtyk-yaprak, Ali-Shaytan* varieties). Such ancient grape varieties as *Kizil Sapak, Terbash, Kara terbash, Kara uzyum ashkhabatskiy, Melei, Gurgon and Khan uzyum,* being descendant of the Greco-Parthian cultivated plant varieties, preserved a high resistance to high temperature. Even today, wild grape specimens are used to create vine varieties. Many varieties

of breeding grape combine high temperature resistance with good eating and commercial qualities. The importance of local seedless grape varieties should be particularly noted. The local population has created such outstanding varieties as *Mamidon, Irtyk yaprak, Gechi Kyrlen, Karadag uzyum nukhurskiy, Nuhurskiy krupni, Peyneri, Meskhen, Ekdona turkmenskaya, Pyrt-pyrty, Sary Aygyr and Kishmish krasniy turkmenskiy*, and developed unique methods for their cultivation. The vine is very sensitive to summer soil and air drought, and particularly to winter drought in the absence of winter irrigation (Nosulchak 1984). The MRPDC collection includes 419 accessions of grape, of which there are 29 genotypes of wild forms and 34 varieties of Turkmen origin, including seven ancient varieties of Greco-Parthian cultivated crops.

This review of live collectiona of fruit crops *in-situ* and ex-situ is aimed at forming a valuable information resource for future research, training and practical use by farmers in breeding on their farms.

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CONSERVATION AND SUSTAINABLE USE OF SIEVERS APPLE TREE GENEPOOL IN KAZAKHSTAN

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Kazakhstan occupies a vast area in Central Asia (more than 2.7 million sq. km.). Two major floristic regions are merged here - Boreal and Mediterranean, and almost all natural-landscape zones of the world are presented: from dry subtropical to alpine tundra, where only the flora of higher plants has more than 6,000 species, including endemic and relic. The territory of the Republic is the northern tip of the Central Asian cultivated plants' focus of origin; 38 important agricultural crops have originated in this area.

Kazakhstan is the diversity center of 157 plant species, which have been the progenitors of 17 cultivated plant species. The representativeness of Central Asian agricultural crop flora progenitors differ significantly in groups of crops, the most completely represented are the fruit crops which make up 90% of the total (Djangaliev 1977).

Sievers apple (*Malus sieversii* (Ledeb.) M. Roem) is an anautochthonous representative of Kazakhstan flora. Fossils related to the mid-Cretaceous period (110 million years ago) testify to the ancient history of the wild apple tree in Kazakhstan. Over a long period of evolution, the apple tree of the Kazakhstan mountains has developed specific genetic characteristics with a wide norm of reaction ensuring its adaptation not only in its historical homeland, but also far beyond it (Djangaliev 1977). This is evidenced by the study of 24 laboratories in the United States, France, England, Germany, New Zealand, which found that varieties of wild apples from Kazakhstan have a high stress tolerance and successfully grow in a wide range of soil and climatic conditions in these countries (Djangaliev *et al.* 1994, Hokanson *et al.* 1997, Harris *et al.* 2002) . The scab and powdery mildew resistance genes have been identified.

Sievers apple grows on the mountain slopes at an altitude of 800 to 2000 m. above sea level. Large forests are formed in the Trans-Ili Alatau, at the northern foot of which lies Almaty and 400 km northeast in Jungar Alatau. The extreme northern point of the apple tree habitat advanced by another 400 miles in Tarbagatay, which is a part of the Alatau mountain ranges. The southernmost point of the apple forests and areas of research are the more arid Talas Alatau and Karatau, which verge into the mountains of Kyrgyzstan, Uzbekistan and Tajikistan.

Since the early 1980s, it was found that Sievers apple in Kazakhstan is endangered in natural ecosystems; nowadays the fruit forest area is only 20% of its extent in the 1930s in the central part of the Trans-Ili Alatau. The degradation of forest fruit is also observed in Jungar Alatau, but its rate is lower than in Trans-Ili Alatau. The average apple forest preservation rate in the period from 1960 to 2000 is 81.7%; the average rate of this forest area reduction is 0.6% per year. Intensive fruit forest degradation in Trans-Ili and Dzungarian Alatau is due to the impact of negative anthropogenic factors (Djangaliev 2007).

These data substantiate the need for urgent measures to preserve the Sievers apple gene pool in the forests of Trans-Ili and Jungar Alatau and the primary fruit diversity ecological systems. Under conditions of Sievers apple tree populations' genetic erosion, the crucial measure for their protection is the restoration of the natural populations' genetic structure. This requires determinacy of each seedling used in reforestation. Such determinacy can only be achieved by using clonal material. To restore the possibility of Sievers' apple natural regeneration, it is necessary to implement complex breeding and forestry activities to prevent the genetic erosion of local populations. The only solution to this problem is to conduct in the near future reforestation by Sievers apple clones obtained on the basis of the natural populations of Trans-Ili Alatau and Jungar gene pools on the breeding plots. These clone varieties correspond to the genetic structure of natural populations and therefore their use in reforestation will not cause genetic degradation of natural ecosystems (Djangaliev 2007).

Twenty-seven species of Sievers apple clones developed by an academician of NAS RK, A.D. Dzhangaliev, are protected by copyright certificates and patents, and incorporated into the State Breeding Achievements Register of the Republic of Kazakhstan. Each of these Sievers apple clone varieties is characterized by genetically determined valuable features and conforms to the variety of natural populations' genetic structure.

In addition, the supply of fruit having a high nutritional bioviability and containing almost all the human requirements for biologically active substances and minerals is an important task in the Republic of Kazakhstan. Patented clone varieties of Sievers apple are an excellent fruit staple solution of this problem. Among the clones there are table varieties, the fruit quality of which is competitive with those of cultivars in the fruit market. There are also industrial clone varieties, which provide high-quality raw material for canned fruit and wine industries. A higher content of pectin allows using such varieties for the production of apple juice, jam and confectionery without gelling additives. Clone varieties of Sievers apple suitable for the production of quality alcoholic beverages such as cider and calvados have been identified and processing technology has been developed (Djangaliev *et al.* 2008). At the same time, these clone varieties combining valuable inherited traits with genetically determined stress tolerance are the basis for the formulation and development of programs for the breeding of fundamentally new and highly productive cultivated varieties.

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GENE POOL OF HORTICULTURAL SPECIES ROOTSTOCK IN KAZAKHSTAN

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In modern horticulture ingrafted crops are of great importance because such traits as tree height, early fruiting, yield capacity and fruit quality largely depend on rootstock. Due to the diversity of soil/climatic zones in Kazakhstan, it is important to have a large collection of seed and clonal rootstocks that respond differently to environmental stresses. Well-chosen variety rootstock compositions can significantly increase the productivity of trees and affect the economic efficiency of tree-growing (Izbasarov *et al.* 2000).

The fruit crop gene pool of Kazakhstan consists of naturally growing and introduced species, varieties and lines. A.D. Djangaliev has conducted important research to identify genetic resources of apple and apricot forests in the south and southeast of Kazakhstan, their internal diversity, conservation and use in the production of seed stocks (Djangaliev 1977). Wild fruit species of the northern Tien Shan, such as Sievers apple (*Malus sieversi*), Niedzwiecki apple (*Malus niedzwetzkyana*), cherry plum (*Prunus cerasifera*), wild apricot (*Armeniaca mill*) are the primary seed stock for fruit trees in Kazakhstan. In addition to the wild fruit species, the gene pool of “Kazakh Scientific Research Institute of Horticulture and Viticulture” Limited Partnership consists of introduced species, varieties and lines of vegetatively and seed propagated rootstocks of apple, pear, plum, cherry and apricot trees.

During long-term studies (in breeding shed, nursery, gardens) of the clonal rootstocks’ large gene pool, a group of dwarf and semi-dwarf apple tree forms (Arm 18, 62-396, B7-35, B16-20, Zhetysu 5) have been selected for their economic and biological characteristics, which are superior to those of their foreign counterparts M9 and MM106. At the present time, the study of new stocky clone apple rootstocks of Kazakhstan selection, the “Zhetysu”series (MSAU-64-143, 08/06/70, 71-3-150, Orenburg Horticultural Experimental Station, “Ural” Series 3-5-1, 04.05.11, 6-4-8, 6-20-1, 7-8-5, Crimea K 103, K 104, K105, USA-MARK) have begun in the gardens. In the South Kazakhstan region, studies on the selection of variety-rootstock combinations of apple tree have been started. Rootstocks 62-396, Arm 18, B7-35 and B16-20 are being studied with Golden Delicious, Reinette Simirenko, Borovinka Tashkent and Anfisa varieties (the last

three are obtained through the selective breeding program of the R.R. Shreder Uzbek Scientific Research Institute of Horticulture, Viticulture and Winemaking). In this region, Borovinka Tashkent and Nafis varieties, in combination with the stock B7-35 and Arm 18, excel. The yield capacity of these varieties' rootstocks during the years of study averaged 108-188 kg/ha (Karichev *et al.* 2009).

Apple rootstocks 62-396, Arm 18, B7-35, and B16-20 were included in the State Register of Breeding Achievements and were released in the Republic of Kazakhstan, in Almaty, Zhambyl and South Kazakhstan provinces.

In Saryagash district of South Kazakhstan province, on the farm "Saryagash Jer syi", an experimental garden of Golden Delicious variety apple trees in combination with the rootstock of the new generation was established.

Of the 46 pear varieties and lines studied, small-height seed stocks of East Asian groups: Xiang Li, Ji Li, Ming Yueh Lee, Bai Li and Chang bai, as well as vegetatively propagated quince (EMC-10, K13) have been selected. Lesnaya and Talgar krasavitsa (Mary Loise) varieties on these rootstock exceeded the standard combinations by 1.7-8 times (seedlings and clonal forestry pear quince EMA).

Assortments of dwarfish rootstocks of the stone fruit crops in Kazakhstan are limited, especially for plum. The primary rootstock for plum is cherry plum (*Prunus cerasifera*). Felt cherry (*Cerasus tomentosa*, Chinese dwarf cherry) is also of a certain value as a rootstock for plums. The increased interest in felt cherry as a rootstock is not only due to the fact that it deters the height of the grafted varieties, but also is very simple in reproduction. In Kazakhstan felt cherry was introduced in 1936 by V.P. Ponomarchuk from the Far East. It has been studied not only as fruit crop, but also tested by S.N. Djangaliev and Sh.A. Khabibulin as a rootstock for the plum tree in combination with Anna Spath, Vaneta, Victoria, Edinburgh, Yellow Hopty, Kazakhstan, Opatija, Okiya, Altana greengage and Markov varieties. Of the studied varieties, good results were shown only in combination with plum varieties Vaneta, Zheltaya Khopti and Edinburgh. Further studies of felt cherry had been conducted at "Kazakh Scientific Research Institute of Horticulture and Viticulture" Limited Partnership. Along with the rootstock, a large collection of plum and large-fruited cherry plum varieties of various ecological and geographical origins (Tulpar, Stenley, Kyrgyz superior) standard seedling had shown best viability. According to the research test in the gardens, the highest-yielding plum varieties were Stenley, Viktoria, Kyrgyz superior and Edinburgh.

Out of the studied cherry seed and clonal rootstocks, in combination with Komsomolskaya and Lyubskaya varieties, the best results were shown by cherry VP-1 and Colt line (Kolt) seedlings. Average yield from these rootstocks was 100-130 c/ha. At present, the gene pool of fruit crop rootstocks in Kazakhstan consists of 49 lines, varieties and species. The collection from different horticultural regions of the world contributes to the agricultural biodiversity of the Kazakhstan fruit crop and allows the utilization of their genetic and biological potential in the production of fruit crop seedlings and the creation of modern gardens.

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CRYOGENIC BANK OF APPLE GERMPLASM IN KAZAKHSTAN

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The territory of Central Asia is a primary center of origin of one of the most important fruit crops – the apple tree (Vavilov 1987). Obviously, the wild ancestor of the cultivated apple varieties *Malus domestica* Borkh is wild *Malus sieversii* (Ledeb.) M. Roem (Robinson *et al.* 2001, Ponomarenko 2009). Research over a period of many years of the wild *Malus sieversii* apple in mountain ecosystems of Kazakhstan has revealed its higher polymorphism by size, shape, colour and taste of the fruit, maturity time and many other valuable breeding traits (Djangaliev 1987, Djangaliev *et al.* 2001).

On the territory of Kazakhstan there are three apple varieties, and the main one in wild forests is Malus *sieversii* (Ledeb.) M. Roem. Unfortunately, as a result of human economic activity, abiotic stress factors and environmental pollution, the unique gene pool of the wild apple, which is of global significance, is under the threat of extinction.

In practice throughout the world, in addition to the traditional methods of biological diversity conservation, the cryogenic conservation methods of germplasm are widely used. Cryogenic deposition of the samples at a very low temperature (-196°C) protects collections from the effects of unfavorable environmental factors, dangerous diseases and pests. Deposited cells, tissues, and organs of plants retain their viability and genetic stability, allowing regeneration of a whole plant that would be a clonal progeny of the original plant.

Cryopreservation of *Malus* germplasm is handled in two ways. Transactions of apical meristems and dormant buds have been developed and are being applied to the varieties and selected species of apple species that propogate vegetatively (Romadanova *et al.* 2007). In order to preserve biological diversity of the wild apple, seed cryopreservation is applied (Kushnarenko *et al.* 2010).

The technology of cryopreservation of apical meristems is a multiple-stage process which includes obtaining aseptic seedlings, their cold adaptation, isolation of their meristematic tissues, their cultivation on a Murashige-Skoog medium with osmotikom, treatment by cryoprotectant and immersion in liquid nitrogen.

We have conducted a test to compare the efficiency of the three methods: slow programmed freezing, encapsulation-dehydratation and vitrification to cryopreserve the apple's apical meristems. It has been determined that the most

effective method of apple apex cryopreservation is the method of vitrification, stages of which we had optimized. Application of our improved method of virtification ensures up to 80% of apple apical meristems' viability depending on genotype. The cryogenic collection of isolated tissues of *Malus sieversii* promising varieties (*Malus domestica* Borkh.) and lines have been established and is being replenished (Ledeb.) M. Roem).

In 2008-2010, Sievers apple survey expeditions were conducted in Zaili Alatau. As a result of several expeditions, 74 samples of apple seeds with total amount of 5690 units have been collected.

Each sample has been evaluated by descriptors, such as geographical coordinates of the collection location (latitude, longitude, altitude above the sea level) and morphological traits (tree height; crown shape; fruit size, shape, colour and taste; leaf shape).

It has been noted that collected samples vary greatly in habitus of the crown – tall, low, bushy; size and shape of the fruit – small, medium, large; taste (from bitter to sweet-sour). Colour of the fruit varies from light yellow to red.

In order to develop cryopreservation protocols, 60 seeds of each sample were selected. The seeds were placed in cryovials and immersed in a Dewar flask with liquid nitrogen for 30 minutes. Seed viability after freezing was evaluated by two methods: by staining in 1% solution of 2, 3, 5-tetrazolium chloride (TTC) and by germination in a greenhouse. For staining of the seed, the coat was removed and placed in an embryo solution TTC for three hours.

Pink color indicates tissue viability. For germination, seeds were superficially sterilized in 20% solution of deochlorine for 10 minutes, washed with tap water and placed in a box for planting in moist perlite at a depth of 1 cm. For the period of eight weeks, the seeds were stored at the temperature of 4°C for stratification, and then were transferred to the greenhouse at 24°C. Germination and germination power of seeds in control and after storage in liquid nitrogen was assessed.

As a result, studies showed that the viability, germination and germination power of the majority of the tested samples did not differ from those after control or even increased after freezing in liquid nitrogen. Staining in a solution of TTX allowed detection of up to 83% of viable seeds after low temperature storage.

Upon germination of seeds in the greenhouse, viability of 80% of the *Malus sieversii* accession after deep freeze did not decrease in comparison to control seeds.

On the basis of our improved cryopreservation, the cryobank containing meristems and buds of 124 local and foreign apple varieties and 74 wild apple accession seeds (*Malus sieversii)*, (*Malus domestica*) was established.

The cryopreservation technology can be effectively used for long-term and reliable conservation of the biodiversity of cultivated apple and its wild relatives for the purpose of theoretical research, practical developments in the field of breeding, and for international exchange of germplasm samples.

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FRUIT CROP DIVERSITY OF WESTERN PAMIRS

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In Gorno-Badakhshan Autonomous Province fruit crops have been cultivated since ancient times, although the time of their emergence can be determined only approximately. Apparently the emergence of the initial centers of fruit-growing culture is associated with relict tertiary forests, where people found more favorable climatic conditions, procuring abundant food from wild plants, especially fruit (Zapryagaeva 1964).

The history of many fruit crops covers thousands of years. It is possible that fruit cultivation here, in Gorno-Badakhshan Autonomous Region, began earlier than that of most of the other crops (Nosirov 2000).

Wild fruit crops, except for walnut, pistachio, almond and pomegranate, are characterized by low taste qualities and are not suitable for fresh consumption, but they can be processed for juices, jams, compotes and dry fruits. This primarily refers to the apple, plum, currant, cherry plum, pomegranate, sea buckthorn, grape, barberry, etc.

Fruit trees grown from the seeds of local reproduction are more tolerant to high summer temperatures and low atmospheric humidity. Scientists believe that Gorno Badakhshan is one of the world's centers of origin of many wild crops like cereals (wheat, barley), legumes (chickpeas, peas) and other useful plants cultivated under different conditions (mulberry, apricot, pear), the richest source material for plant breeders. The Western Pamirs has a treasury of original varieties and species of plants, including wild fruit.

In Gorno-Badakshan Province, apple and pear trees are the most promising of the pomaceous fruit species. There are both wild and cultivated forms. Orchards in Badakhshan are situated in the habitats of wild fruit bushes.

Gurskiy (Gurskiy 1964) noted that the study of wild apple varieties and its assortment in Tadjik gardens demonstrated the following: the western regions of Gorno Badakshan Autonomous Province is the center of diversity of the apple tree. Wild apple tree is highly polymorphic in all traits.

In Gorno-Badakshan Autonomous Province apples are highly polymorphic. They vary greatly in size, height and diameter. The fruit height varies from 51 to 60 mm. Correlations between the apple size and their growing altitude zones have

been detected. According to the "Classifier of *Malus* Mill genus" (1976), apples are divided into very small (25 g), small (26-50 g), medium (70-100 g), large (126-175 g) and very large (over 175 g).

Among wild varieties there are some very valuable ones, with fruit from one tree weighing up to 150-200 g and good taste. As a result, local wild forms were adopted by the ancient inhabitants of Badakshan and improved through selection and maintenance of trees.

The research showed that in addition to cultured pear trees in Gorniy Badakhshan there are wild thickets as well. Gurskiy A.V. has discovered that there are Kayon, Sagakamrud and Yamchun pear tree varieties in natural groves. In total, 15 local varieties have been discovered and described. In Gurskiy's opinion, Cajon (Pints Cajon) macropolous is found in natural woods. Small-fruited Cajon in gardens can become large-fruited if grown under favorable conditions.

The habitat of pear in Gorniy Badakhshan is situated at the altitude of 1100-2500 m. above sea level. However it should be noted that this limit is not the same for all local varieties; various varieties of pear grow in different habitats.

The wild Yamchun variety is endemic and relict to Gorno-Badakshan Autonomous Province. Cultivated trees of this variety are very rare. A small natural grove of this pear was found in Yamchun village. Some of those trees were 200 years old.

Cajon pear grows in the wild and is being cultivated as well. The Cajon pear habitat is located at an altitude of 1100 to 2500m above the sea level. In Gorno-Badakshan Autonomous Province pear grows in the following regions: Valley of Pyandj, along Kalay-Khumba-Anderob, Vancha Valley up to Poymazor village, Bartanga Valley, Gunt Valley from its source to Pitfondj village, and Shohdara Valley. In Pitfondj village wild pear grows at an altitude of 2600 m. above sea level. The habitat and environmental prevalence of the pear leads us to conclusions regarding its autochtony in Gorniy Badakshan.

The taxonomy and biology of Gorno-Badakhshan pears is of great interest to scientists. In thickets and gardens, there are four clearly distinguishable morphological forms of pears. The main form occurring in natural habitats is certainly the pear known as Cajon.

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VITICULTURE AND CULTIVATED VARIETIES IN NORTH TAJIKISTAN

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Fresh grapes are valuable sources of nutrition and diet food products. According to medical recommendations, its annual average consumption per capita should amount to 6-8 kg.

The dietary and nutritional value grape is in the first place determined by a high content of digestible sugars – glucose and fructose—as well as a rich composition of valuable macro-and micronutrients and vitamins.

As a result, fresh grapes have been used for more than a century as a medicinal plant. Based on these grape qualities, a method of medical treatment (ampelotherapy) using grape has been developed and is being applied in a number of specialized clinics.

Tajikistan, due to its exceptionally favorable climatic conditions, has a long history of grape cultivation, as well as being one of the major areas of introduction of the grapevine in agriculture. It specializes in the production of table and dried grapes and is one of the world's leading grape-growing regions that produce high-quality table grapes. Cultivated in Tajikistan Early- and very early-maturing table varieties provide supply of fresh grapes "from the bush" in mid-July. In Tajikistan, as well as throughout all of Central Asia, viticulture dates back to prehistoric times. Viticulture and winemaking in the territory of contemporary Tajikistan had undergone significant development even before the conquests of Alexander of Macedon (fourth century BC). Based on the notes of his companions, the Roman historian Quintus Curtius Rufus (first century BC) states that "the nature of Bactria has a variety of multilateral and diverse properties: there are many trees and grape vines that feed abundant and sweet fruit." In the valley of the Zarafshan River, inhabited by the ancestors of modern Tajiks, viticulture had developed long before the Greek conquest of Central Asia.

On the basis of thorough research, Vavilov came to the conclusion that Tajikistan serves as the center of diversity and the center of origin of many crops, including apricot and grapevine. Over the long history of viticulture development in Tajikistan, there have been periods of heydays and decline. Viticulture reached its maximum development in the seventh through twelfth centuries AD.

The soils of Tajikistan in the viticulture areas are mostly gray soils, ranging from light to dark. Light gray soils are common in the hottest areas of the country, former semi-deserts (the Vakhsh Valley). In other valleys there are typical gray soils, and in the foothills dark gray soils are common. On all of these soil types, with good care, vineyards give high yields - in some cases up to 30-40 tons per hectare and above. In recent years, lithosolic soils (stony and rank) with a low content of silt are being developed for vineyards. Grape yields are slightly lower on the gray soils, but its cultivation is the most cost-effective in comparison with other agricultural crops.

In accordance with environmental economic conditions, the viticulture area of the Republic is divided into the following zones:

1. Gissar, covering valley and foothill areas of the Republic;
2. Sughd, including regions of northern Tajikistan;
3. Vakhshs, including southern, hot climatic regions of the Republic;
4. Kulyab, situated in the southeast of the Republic;
5. Foothills of the Garm Mountains.

In the period of new economic development in the country, addressing such important issues is especially acute. In order to fulfill this complicated task, first of all, it is necessary to apply a set of technical measures to identify and use promising grape varieties with high-yield potential in every province of the Republic.

In the central part of the territory there is a narrow, sloping plain, which is an extension of the Fergana Valley, and to the west it gradually changes into Golodnostepnaya plain. The narrow strip of Sogd valley zone is the lowest part of the Republic. The Syr Darya River is located at the altitude of 350-400 m above sea level. A considerable part of the territory is occupied by the Turkestan and Zarafshan ranges and their foothills; natural conditions are much different from the conditions of the valleys, so that two climatic sub-zones can be distinguished—valley and foothill.

The valley sub-zone, covering Kanibadam, Gafur, Spitamen, Matchin and Zafarabad Regions, is characterized by an extreme continental climate with hot dry summers and relatively cold winters. Precipitation here is very low (average long-term rate is 152 mm) and the cultivation of grapes is only possible with irrigation. The frost-free period is lasts over 200 days and the sum of degree-days temperature reaches 4,500°C; these conditions are sufficient for any variety maturation. In this sub-zone the grapevine grows in the open air, but in some, especially where winters are harsh, air temperature drops down to -20°C and vines can be damaged by winter frost, and thus need to be sheltered. In this regard, it should be noted that the most common variety in this zone is Tagobi, which, along with its berries' high quality, is extremely cold tolerant.

Grapes are mainly used for raw consumption and wine making. The main varieties are Tagobi, Shakar angur and Khusayne kadu. In recent years, the most popular table varieties are Angur Kalon (Nimrang) and pink Tayfy, the most common wine varieties are Rkatsiteli, Saperavi and Bayan Shirei. In other sub-zone regions vines are few and are used primarily for raw consumption.

In the future, expansion of areas under grapevine cutivation will be effected mainly through the development of land that is unsuitable for other crops. These are areas of Big Asht, Samgar and Kizilinsk comprising several dozen thousands of hectares. The main specialization of new vineyards should be the production of raw materials for dried products and table grapes of early and late maturing type, suitable for export to the country's northern regions and for winter storage.

The foothill zone includes Istaravshan, Ganchin and Pyandjikent Regions, and is one of the most ancient viticulture centers. Almost half of all vines in the Republic are grown in this sub zone. Viticulture in this region has for a long time specialized in the production of dried fruit, and this fact affected the choice of varieties grown here. In Pendjikent Region the majority of grapevines are of the Sultana variety. In Istaravshan and Ganchi Regions the most common are Black Sultana, White Sultana, Angur Kalan and Chilyaki varieties, their berries being widely used for raisin production.

The climate of this sub-zone is milder than that in the valley. The frost-free period is continuous, and lasts 200 days. The sum of degree-days exceeds 3,500°C and is sufficient even for the latest-maturing grape varieties. Precipitation is 250-300 mm and for the most part falls in the winter-spring period. In some years rain in August severely damages the vineyards, causing rotting of the berries, especially of "Chilyaki" variety.

This zone's soils are highly fertile typical and dark grey soils. Grapevine plants are covered with the soil in winter season to protect from frost and cold, although winters are temperate and minimum temperatures rarely drop to -18°C. Observations made at the Ura-Tybe control station at the Scientific Research Institute of Horticulture and Viticulture showed that grapes can be grown unshielded in the open as well.

The variety is the lowest taxonomic unit of the cultural grape, characterized by a distinctive set of hereditary morphological, biological and economic characteristics. Varieties are divided by origin into following groups:

- Local, or indigenous—brought under cultivation as a result of people's selection, i. e. continuous natural and later artificial selection of the most valuable commercial varieties growing in the ancient centers of grape origin;
- Introduced—best varieties introduced in some viticultural regions from other continents;
- Selected—new varieties developed by breeders through methods of hybridization (interspecific, intraspecific) clonal selection and by artificial mutagenesis.

By origin, breeding methods, and biological characteristics varieties are classified as follows:

- Population varieties – often old, local varieties; a set of clones that preserve the local traits and adaptability to certain conditions;
- Clonal varieties – vegetative offspring, selected by one valuable essential feature. The majority of cultivated varieties are mixtures of clones;
- Hybrid varieties – especially selected from the progeny of crosses between two or more plants, inheriting valuable properties from their parents.

In accordance with their properties and their preferential uses, these grape varieties are divided into:

Table: grown mostly for raw consumption. As a matter of fact, they have large racemations, large berries, an attractive appearance and are highly palatable.

Industrial: grown for wine making and juice extraction. The main trait of the berries is the high percentage of juice content (75-85 % of the total weight). Racemations and berries are not large but their yield is rather high.

Seedless: grown mainly for raw consumption and dry fruit production.

Universal: grown mainly for raw consumption and processing. According to the characteristics of their racemations and berries, these varieties are larger than industrial grapes and smaller than table ones.

According to the terms of maturation, grapes are divided into eight groups. The basis of such a division is the number of days from breaking of bud to full maturity. According to this trait, varieties are classified as follows:

- Extra early season (up to 105 days);
- Very early season (105-115 day);
- Early season (115-125 days);
- Early mid season (125-130 days);
- Mid season (130-135 days);
- Mid-late (135-140 days);
- Late season (140-145 days);
- Extra late season (more than 145 days).

Grape varieties can be classified by their disease and pest resistance. Pest and disease resistance of grape varieties' is evaluated on a five-point scale:

0 points immune varieties, do not need chemical protection;

1 point almost-immune varieties slightly affected by disease; can be grown without chemical protection;

2 point highly resistant, slightly affected by disease, and can be grown without chemical protection;

3 points relatively resistant, with medium disease resistance, require about two prophylactic sprays during the growing season usually before flowering, and when the berries are of a pea size;

4 points susceptible, strongly affected by disease, need chemical protection (4-5 sprays per season);

5 points highly susceptible, very strongly affected by diseases, and require timely chemical protection.

One grape variety differs from another by different biological indicators, responding differently to the growing conditions, bush formation, and maintenance. That is why different varieties require different agricultural practices, methods of shrub pruning, buds and shoots ratio, watering and spraying practices.

In view of the sector's intensification and transition to the industrial scale, the requirements of varieties have increased.More attention is paid to cold-tolerant, genetically high-yielding varieties with a stable yield and good tasting berries and that are ecologically flexible, suitable for cultivation on adapted land,

highly profitable, with different maturation timing, with a relatively rapid sugar accumulation rate, tolerant to adverse environmental factors such as drought and frost, resistant to fungal diseases (mildew, botrytis decease, *Uncinula necator*, anthracnose), viral diseases and pests (phylloxera).

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ANCIENT APPLE VARIETIES OF SOUTHERN KYRGYZSTAN

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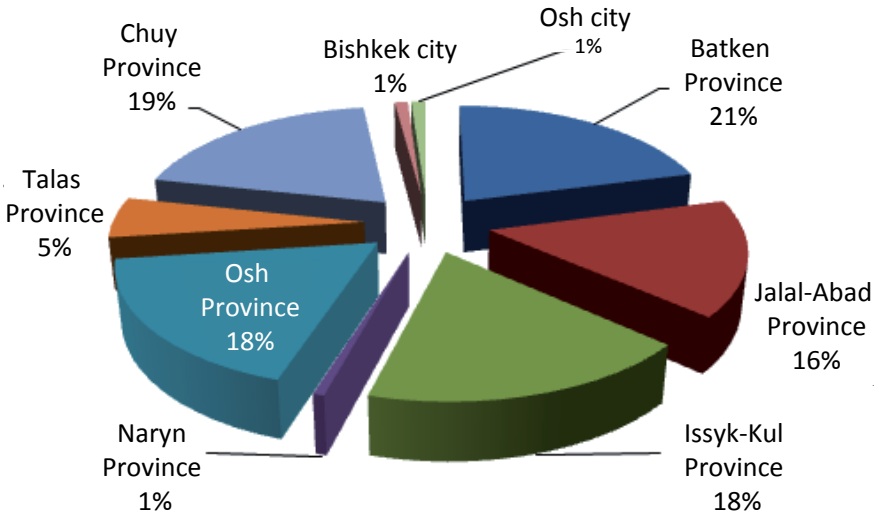
Apple as a fruit species has long been cultivated by man. It occupies more than 80 percent of the fruit tree plantation area worldwide Currently, more than 20,000 varieties are described worldwide. Apple orchards are profitable and are highly important for farms.

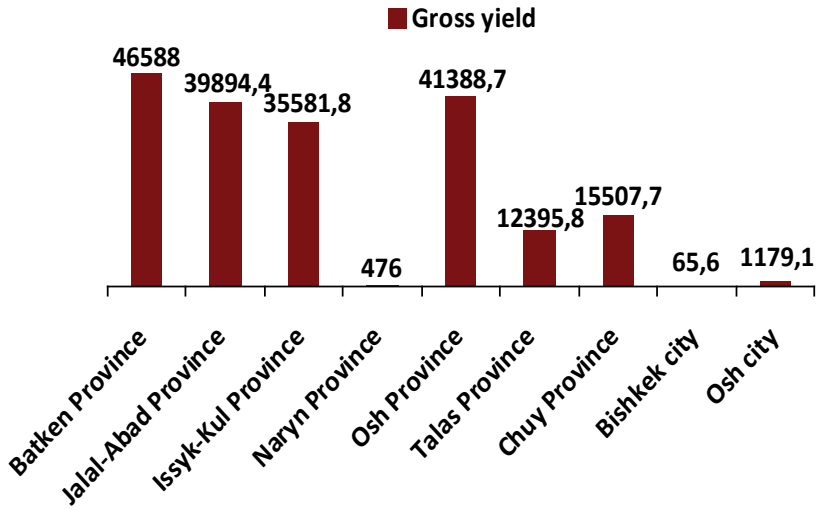
Kyrgyzstan has a great potential for cultivation of fruit and berry crops, the natural conditions in the republic allowing the production of high-quality fruit products. In Kyrgyzstan, plantations of fruit and berry crops occupy 44.6 ha., with an average crop yield of 43.3 Cwt/ha; the gross yield is 193.1 tons (Graph 1).



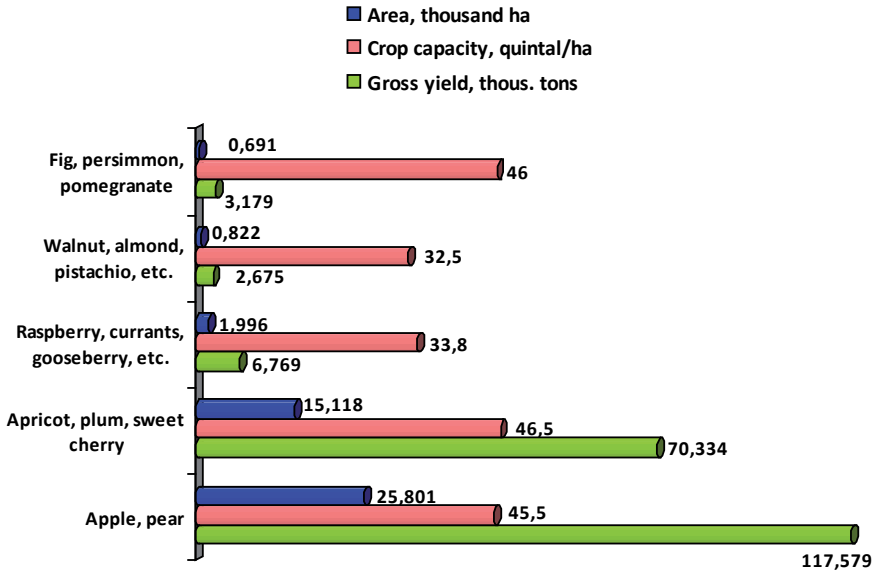
Graph 1. Specific weight of fruit and berry crops at bearing age in the provinces of Kyrgyzstan, 2010.

As shown in graph 1, the largest areas under fruit crops at bearing age are in Batken (21%), Chuy (19%), Issyk-Kul and Osh (18%) regions.

A comparative analysis of the gross yield of fruits and berries for 2010 according to Graph 2 shows that the maximum gross yield was observed in the Batken region (46,588.0 t) and the lowest in the Naryn region (476.0 t) and Bishkek (65.6 t) (Graph 2).



Graph 2. Gross yield of fruits and berries in the provinces of Kyrgyzstan in 2010, tons.



Graph 3. Main economic indicators of fruit and berry crops: gross yield, crop capacity, areas in Kyrgyzstan in 2009

Data on fruit crop capacity for 2009 in the regions (Graph 3) show that the productivity of stone-fruited crops (46.5 quintal/ha) is higher compared to pomaceous (45.5 quintal/ha) and other crops, although stone-fruited crops occupy much less area (15,118 ha) than pomaceous crops (25,801 ha). During recent years, farmers' interest in cultivating sub-tropical and berry crops has increased and an expansion of the area under these crops has been observed (Graph 3).

As it is shown by the data presented above, southern Kyrgyzstan occupies a leading position in terms of area and gross yield as compared to other regions of the republic. Horticulture in southern Kyrgyzstan, as well as horticulture throughout Central Asia, has an ancient history and at the same time is characterized by specific features. Horticulture in southern Kyrgyzstan emerged and developed under the direct influence of the early peoples inhabiting the Ferghana Valley.

Horticulture in southern Kyrgyzstan first developed with stone fruits. The warm climate of the foothills of the Fergana Valley and the long frost-free period contributed to high-quality products, especially dried fruits, mainly apricot. Apple and pear trees occupied a small proportion of total cultivated area. The main sources of apple and pear fruits were their wild plantations. The collection of apple varieties was represented mainly by trees selected by the local populations from wild nut and fruit forests and imported foreign varieties.

Development of horticulture in Southern Kyrgyzstan is divided into four periods:

1. The first period refers to the development of horticulture from ancient times to the end of the eighteenth century. During this period horticulture was developed in south and central parts of southern Kyrgyzstan, whereas in the northern part (Toktogul, Aksy, Ala-Buka districts) there were no cultivated gardens. The population of these areas satisfied their needs for fruits and berries by utilizing the wild nut and fruit forests. Wild fruit plantations in the basin of the Kara-Unkur and Kugart Rivers are distinguished by the extensive polymorphism of apple fruits, especially in average weight of fruits, development of fruit peel color, fruit ripening period and resistance to fungal diseases, particularly scab.
2. The second covers the period between the end of the eighteenth century until the 1980s. During this period new varieties were introduced from different Central Asian regions and local varieties expanded.
3. The third period is marked by the reunification of southern Kyrgyzstan with Russia up to the October Socialist Revolution (from 1876 to 1917). This period is characterized by the renewal of species and variety collections in orchards. This was the period when nursery management originated and horticulture began to develop in mountain districts.
4. The fourth period lasted from the October Socialist Revolution until the collapse of the Soviet Union (1917-1991). This period is characterized by the organization of planned modern horticulture. This was the period when introductions from the European part of the Soviet Union intensified. These varieties were adapted to local conditions and currently are successfully cultivated by farmers in the region.

Due to the transition from centralized to market economy, Kyrgyzstan faced serious challenges in its development. These problems include food insecurity and environmental degradation. The problems of food security forced the development of agriculture in a direction affecting biodiversity. The farmers' tendency to cultivate commercial varieties of fruit trees usually leads to a gradual loss of traditional crop diversity and thereby reduction of crop collections, including those of local crops adapted to harsh local climatic conditions.

The register of agricultural crops approved for use on the territory of the Kyrgyz Republic includes 183 varieties of 18 species of fruit crops. More than 30 percent of them are national breeding varieties. Local varieties are of great importance in farm enterprises. Early varieties in particular are highly popular and generate a huge income for farmers.

In order to develop an effective approach to the conservation of local varieties of fruit crops and their wild relatives and to assess the agrobiodiversity of fruit crops through the GEF project "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia," supported by UNEP and coordinated by Bioversity International expeditionary surveys of farmlands were conducted in Jalalabad, Osh and Batken regions of the Kyrgyz Republic.

According to a survey among farmers, 31 apple varieties of summer, autumn and winter ripening stage, including 27 local varieties, are cultivated in experimental sites in Gumkhana, Dashman, Kaba, Yarodar villages in Bazar-Korgon district, Karalma, Jalgyz-Jangak, Urunbash villages in Suzak district, and Jazy, Krasniy Mayak, Mirzaki, Salamalik villages in Uzgen district. Furthermore, different apple varieties are cultivated simultaneously on a single plot.

The following are the reasons for cultivating different apple varieties: high yield through different ripening stages, the sequence of ripening, ease of gathering and sale of the yield. When selecting varieties, farmers pay special attention to the following criteria: transportability, marketability, taste of the fruits, and resistance to pests. Five varieties (Shafran, Bellefleur, Simirenko, Stakanchik, Jonathan) are widely used on large farms. Six varieties are of average distribution: Aport, Almatinskiy aport, Rosemarin, Almatinskiy Bellefleur, Golden Delicious, Sary Alma.

Poorly distributed 18 varieties include Kyrgyzskoe zimnee, Bellefleur jeltiy, Beliy naliv, Almatinskiy aport, Prevoshodniy, Korona, Kandil synap, Toktogul, Mantuaner, Katuu Alma, Kasilskiy, Aport Alexander, Rashida, Reinette Burchard, Starkrimson, Alamedinskoe, Palmyra and Zolotoy Parmen.

Although farmers have great demand for these varieties, they are poorly introduced in the farms due to lack of planting material.

There are still varieties on farms that do not meet requirements of the market with a periodicity of fruiting (Kasilskiy, Toktogul, Katu Alma, Raika). Farmers are provided with the required recommendations to replace them with other local varieties with valuable economic traits.

Based on the study of ancient apple varieties, morphological and biological characteristics of the varieties and the authenticity of the names were revealed. Using the results of the studies a detailed description of ancient varieties was made.

Local varieties of ancient apple varieties are an important source of income for local populations. They are also important for breeding, in which their valuable traits are used to create new varieties. Therefore, conservation of these rich genetic resources and their sustainable use to improve the livelihoods of the population is a particularly important task at this stage of the republic's development.

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WILD RELATIVES OF FRUIT CROPS IN UZBEKISTAN

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The territory of Uzbekistan, while not large, is an integral part of Central Asia, which N.I. Vavilov (1926) singled out as one of the world's centers of origin of cultivated plants. Despite the fact that over 80% of the territory of Uzbekistan is desert (Kyzylkum and Ustyurt), here all the major spurs of Tien Shan and Pamir mountain systems are found. The desert, as a rule, is a limited arena for the growth of useful plants. In addition, all the Central Asian desert floras are quite recent, not comparable in age with the African desert floras. Therefore, the assumption that the deserts of Central Asia and, in particular, Uzbekistan is one of the centers of origin of watermelons and melons, is bottomless argument. Findings of supposedly wild watermelons in Surkhandarya Region (near Termez) should be, without doubt, attributed to wilding cultivated crops . It is also worth noting that Central Asia was a special, if not the only, region that attracted great interest of Russian, and later Soviet, botanists. It was in the Soviet period that most of the botanical discoveries and numerous finds were made in the territory of Uzbekistan. Hence, a huge number (about 2500) of new species and subspecies of vascular plants have been described, although further studies showed that most of them were described erroneously throaugh mainly herbarium material, which had not been collected by the researchers themselves, but by local collectors.

Great botanical contributions were made by such preeminent florists and taxonomists as B. Fedchenko, M. Popov, E. Korovin, A.A. Vvedensky, S. Kudryashov and R. Kamelin, who described the unique endemic taxa at species and genus level. In addition, these botanists collected plants on the territory of Uzbekistan over several decades and studied plants in their natural habitats.

One of the founders of plant genetics science in the Soviet Union, M. Popov (1929), published one of his base essays on wild fruit trees and shrubs in Central Asia. As the greatest expert on the flora of this region, he identified almost all the

known wild species in the region. There is no doubt that N. Vavilov used data from Popov in the designation of the Central Asian center.

One of the first significant plants is the grape (*Vitis vinifera* L.), which still grows in Uzbekistan in the wild, in the closed middle mountain gorges of the Hissar range (Tupalang River basin).We examined several populations of wild grapes, some with vines climbing sycamore trees up to 20 m height. Berries taste bitter and pungent and do not exceed a diameter of 7 mm. Populations of this species are included in all four editions of The Red Data Book of Uzbekistan.

The next most important is undoubtedly the walnut (*Juglans regia* L.). The question of whether this specie is native to Central Asia or whether it was introduced a few thousand years ago, is still unresolved. Genetic analysis of DNA has shown that we are dealing with a large genomic diversity of this species within Central Asia, although it should be noted that Arslanbob and Pskem populations were not included in the study. Apparently, as rightly pointed by Popov (1929), this area was the southwest center of the origin of many Central Asian fruit species. In Uzbekistan, the walnut forests are located mainly in the western Tien Shan .On the northern slopes there are still nuciferous forests where mesophytic perennials such as *Brachypodium sylvaticum* (L.) P. Beauv., *Dactylis glomerata* L. and *Melissa officinalis* L. dominate.

There is no doubt that wild species of the genus *Malus* Mill grow in Uzbekistan. Primarily, these are *M. niedzwetzkyana* Dieck and *M. sieversii* (Ledeb.) M. Roem.; the presence of *M. kirghisorum* Al. Fed. et Fed in our flora has not yet been confirmed by herbarium material.

More than a dozen synonymous species and variations from the western Tien Shan, and especially Pamiroalay, have been described, indirectly confirming their nativity (*M. anisophylla* Sumnev., *M. heterophylla* Sumnev., *M. hissarica* Kudr., *M. jarmolenkoi* Poljak., *M. kudrjaschevii* Sumnev., *M. linczewskyi* Poljak., *M. persicifolia* Sumnev., *M. schischkinii* Poljak., and *M. tianschanica* Sumnev.). The most likely source is the introduction in the Central Asian flora (as in the case of apricot) of ancestral forms from China. On the other hand, Szechuan small-fruited apple does not relate to Central Asian varieties.

Wild plum (*Prunus divaricata* Ledeb.), without exaggeration, can be considered an ancestor of Central Asian plums. Its yellow and black forms grow natively in the western Tien Shan, where they are harvested in large quantities by the local population.

Genus *Amygdalus* L., having a holarctic type of areal, is represented by a large number of species or hybrid species (*A. bucharica* Korsh., *A. comminus* L., *A. kalmykovii* O. A. Lincz., *A. petunnikovii* Litv., *A. saviczii* Pachomova, *A. spinosissima* Bunge, *A. tianschanica* Sumnev., *A. uzbekistanica* Sabirov*, A. vavilovii* Popov). Being edificators of *shibliyak* formations in the region of Pamir –Alai, *A. bucharica and A. spinosissima* are used as stock material by local populations.

The *Amygdalus* L. genus, with holarctic type of habitat, is represented in Uzbekistan by a large number of species, including hybrid ones (*A. bucharica* Korsh., *A. comminus* L., *A. kalmykovii* O.A. Lincz., *A. petunnikovii* Litv. *A.* sa*viczii* Pachomova, *A. spinosissima* Bunge, *A.tianschanica* Sumnev., *A. uzbekistanica* Sabirov, *A. x vavilovii* Popov). As aedificator of *sibljak* formations in Pamir-Alay,

A.bucharica and *A.spinosissima* are used as rootstock by local populations. Worth noting is that the last hybrid species that can still be found in Nurata Ridge.

Another Holarctic genus, *Pyrus* L., is represented only by one type in Uzbekistan, *P. regelii Rehd*, which was described by Popov by seeds. *P. asiae-mediae* (Popov) Maleev from Pskem Valley, was included in all four editions of the Red Data Book of Uzbekistan, although it has never been collected by anyone else.

Undoubtedly, while available in Uzbekistan, *Diospyros lotus* L. is of Chinese origin. Wild populations of this species have been studied by the authors in the enclosed lowland valleys of Hissar Range (Tupalang River basin). The fruit tastes tart and pungent and does not exceed three cm. Populations of this species are included in all four editions of the Red Book of Uzbekistan.

Another unique occurence in the Tupalang River basin are small groves of wild fig (*Ficus carica* L.). Strong trees grow on the rocky talus of the Tupalang and Sangardak River basins. The taste of the fruit is pungent, but they do not exceed a diameter of three cm. Populations of this species are included in all four editions of The Red Book of Uzbekistan (2010).

Populations of wild pomegranate (*Punica granatum* L.) were also studied in the Tupalang River basin. As a rule, they are small trees or shrubs, growing on silty slopes in the lower mountain belt. The taste of the fruit is tart and pungent; they do not exceed five cm in diameter. Populations of this species are included in all four editions of The Red Book of Uzbekistan.

Here were also found populations of Chilon (*Ziziphus jujuba* Mill.), a tree which is also confined to the warm southern slopes of the Tupalang River basin. The fruit is rather dry and astringent does not exceed a diameter of three cm. Populations of this species are included in all four editions of The Red Book of Uzbekistan.

Mulberry (*Morus alba* L. and *M.nigra* L.) can be called a symbolic, favorite delicacy in Uzbekistan, especially the latter type, which people call “shotut”.

The same can be said about pistachio (*Pistacia vera* L.), wild thickets of which are mainly located on Babatag Ridge. There is no doubt that this purely Central Asian form is no worse than Iranian varieties on the basis of *P. khinjuk* Stocks by taste. With its African roots, pistachio has evolved in Southwest and Middle Asia.

Another favorite fruit is Boyarka *Crataegus pontica* Koch, which can be found in all the bazaars of Uzbekistan.

Wild sea buckthorn (*Hippophaë rhamnoides* L.) grows in the floodplains of mountain rivers, and is not very popular among the local population.

The same is true for Eastern oleaster (*Elaeagnus angus tifolia* L.), which also grows in mountain and river valley floodplains.

Wild cherry in Uzbekistan is mainly represented by microcarpous varieties (*Cerasus alaica* Pojark., *C. amygdaliflora* Nevski, *C. erythrocarpa* Nevski, *C. mahaleb* (L.) Mill., *C. tianschanica* Pojark., *C. verrucosa* (Franch.) Nevski). These varieties can be used for breeding new resistant ones.

In the Hissar Mountains, the currant bushes of *Ribes malvifolium* Pojark, and in the Ugam and Pskem ridges the *R. janczewskyi* Pojark. and *R. meyeri* Maxim currants have been detected and studied. These wild currant relatives are almost indistinguishable in taste from the cultivated varieties. Hissar endemic *R. malvifolium* is included in all four editions of the Red Data Book of Uzbekistan.

The genus *Berberis* L. is represented by three wild species (*V. integerrima* Bunge, *B. nummularia* Bunge and *V. oblonga* (Regel) Schneid.). This barberry grows throughout the mountainous areas (in the floodplains) in Uzbekistan, and the local population harvests the fruit in large quantities, using it as a seasoning.

Rubus caesius L. is also very common in mountain regions (in the floodplains) in Uzbekistan and is widely used by local populations.

The territory of Uzbekistan is thus an integral part of Central Asia and is still a refuge of fruit plants' wild relatives. This wealth of breeding material, of course, must be conserved and utilized by scientists to maintain the old and breed new fruit varieties.

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THE NUMBER AND DISTRIBUTION OF WILD FRUIT CROP RELATIVES IN KAZAKHSTAN

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The implementation in Kazakhstan of the GEF project "*In situ*/on farm conservation and used of agricultural biodiversity (fruit crops and wild fruit species) in Central Asia" supported by UNEP and coordinated Bioversity International has raised the question about the correct definition of both wild relatives of cultivated plants and alien species that are intruders in natural ecosystems. Specification of the "wild relatives" and "alien species" concepts has allowed the development of a common classification of fruit and nut plants in the natural ecosystems of Kazakhstan and the identification of regional specificity of the distribution of natural and alien species.

The question of wild plant species relatedness to crops may have no clear answers, depending on the conceptual ideas about the form of the organism. From the standpoint of the Convention on Biological Diversity, the main feature of this relationship is the realizable exchange of genetic material between wild species and cultivars. We are talking about the possibility of such an exchange in nature, not through biotechnological and genetic engineering means (Chekalin & Nurmuratuly 2010).

According to a widespread current idea, the synthetic theory of evolution (Huxley 1942, Mayer 1981, Petrova 2009), the specificity of the form as a special objective of nature is revealed through its reproduction isolation from others, even the most closely related species of organisms. With this theory, the natural exchange of genetic material between related species is impossible. According

to the synthetic theory of evolution, only one species can be attributed to a wild crop relative—the progenitor of this cultivar, the species which was used to select primary landraces.

The realities of flora are not consistent with the tenets of the synthetic theory of evolution of species' reproduction isolation. Interspecific hybrids of evolutionarily viable plants are widely common, and interspecific hybridization, as pointed out by Rayvn and R. and S. Edvort Ayhorn (Rayvn *et al.* 1990), is one of the most important mechanisms of the evolutionary process. Many species and interspecific hybrids of plants have been determined (Rehder 1949, Cherepanov 1981). It was shown (Sokolov *et al.* 1977) that in the convergence of the natural habitat of species of one genus, there is wide hybridization between them, up to the point of independent hybrid species separation.

Plant interspecific hybridization requires an appropriate understanding of relationships between species and crops. Besides the progenitor species of the crop, all other species of the same genus of plant should be recognized as wild relatives of this cultivar. Kazakhstan scientists have gained such understanding from their analyses of the relatives of crops (Chekalin & Nurmuratuly 2010, Almaty 2005).

Another important issue in determining the nature of agricultural biodiversity, including fruit, is a question of the species' origin in the natural ecosystems of the analyzed region. The great migration of peoples and the world's trade routes resettled plants far beyond the original natural habitat of these species. In Kazakhstan, out of 5658 species of vascular plants growing in the country, 192 species (3.4%) are foreign to the natural ecosystems of the Republic (Abdulina 1998). There are also alien species among wild fruit plants in Kazakhstan.

Paragraph h of Article 8 of the Convention on Biological Diversity obliges member states to prevent the introduction of alien species that threaten ecosystems, habitats or species, or to control or eradicate them. In the "Global Strategy for Plant Conservation", adopted by the 6th Conference of the Parties to the Convention in 2002, alien species are divided into "core" (the most threatening) invasive and "passive" (non-threatening). This division of invasive species is recognized as the primary one.

Division of alien species into "aggressive" and "passive" is not enough, since it ignores the dynamic variation in time of the habitats' environmental conditions and the phytocenotic role of species. Alien species that somehow found their way into native communities, but are not yet self-reproductive (seed and vegetative reproduction), should not be defined as "passive" but rather "latent" or gestating. It is possible that under certain changes of environmental conditions, the "latent" species can develop phytocenotic aggressiveness. The next category after "latent" is "potentially invasive" alien species. Such species are characterized by limited self-reproduction in natural communities and currently do not significantly affect the natural ecosystems. The share of "potentially aggressive" forms in the general population and in the young population does not exceed 5%. Self-reproducing alien species in natural communities, which make up more than 5% in the general population and (or) more than 5% of the population of young plants should be

recognized as "aggressive." Invasive alien species substantially transform natural communities, making them alien to the ecosystem (Chekalin 2007).

As noted earlier, the settlement of alien species in natural ecosystems and their naturalization in these ecosystems are processes that develop over time. Such naturalization was occurring thousands of years ago and is still going on. Some old naturalized species have become an integral part of natural ecosystems, which are currently in a state of evolutionary stability.

Moreover, an invasion of some old naturalized species may lead to destabilization of the natural communities and thus such species should be taken and indeed are being taken under state protection. This state action establishes the protected species status with the implementation of special protection regimes. There are such species among wild fruit plants in Kazakhstan (*Vitis vinifera* L.)

Based on the above, the criteria for assessing the status of species in natural populations should be different for indigenous and alien species. The list of wild and feral relatives of fruit and nut crops in Kazakhstan has been drawn up. Data on species diversity, their division into native and alien to the natural ecosystems of Kazakhstan were provided by Abdulina (Abdulina 1998).

The geographical distribution of species across the state is shown in the "Illustrated plants of Kazakhstan" (Goloskokova 1972). Species that were put on the protected status list are listed in the "Red Book of Kazakhstan" (1981). Phytocenotic characteristics of alien species are identified in the literature (Chekalin 2007, Chekalin *et al.* 2007) and previously published data of field studies.

A list of wild and feral relatives includes 23 species of plants belonging to nine families. Eighteen of these genera correspond to the traditional fruit and nut crops: walnut, hazel, pistachio, gooseberries, currants, almonds, apricot, peach, plum, cherry, quince, apple, pear, raspberries (blackberries), cottony jujube, oleaster, buckthorn and grapes. In Kazakhstan there are naturally-growing progenitors of such crops like common pistachio, oleaster and raspberries (blackberries), which are traditionally harvested in natural ecosystems of Kazakhstan for food. Fruits of hazel pine, Sievers apple and apricot naturally growing in Kazakhstan have previously also been subjected to public procurement.

However, at the present time, these species are under state protection and harvesting of their fruits is prohibited. While the currants, plums and cherries are not represented in the natural ecosystems of Kazakhstan by species progenitors of these crops, their wild relatives have traditionally been collected and used by people. Walnut, and ordinary almond are non-indigenous to Kazakhstan. However, they, and especially walnut, are commonly grown in gardens and forests for fruit. Grape vine is taken under state protection, which prevents its fruit from being harvested in the forest.

The use of fruits of such breeds as barberry, aflatunia, hawthorn and mountain ash may require special explanation. The fruits of barberry are used by people mostly in dried form for boiling compotes and jellies. However, they are also used raw for jam, manufacture of cooking dyes and in the wine industry.

Pontian hawthorn berries are harvested extensively by populations of the region of south Kazakhstan for the production of jams. Also, hawthorn is used in the pharmacopoeia.

The fruits of mountain ash are most commonly used for the production of vodka liqueurs and cordials.

Aflatunia ulmariae itself is not used for food. However, this plant is closely related to almonds, and therefore can be used in their breeding for resistance (especially cold resistance).

Wild relatives of fruit and nut plants are distributed on the territory of Kazakhstan irregularly. The largest number of native species is concentrated in the mountains of southern, southeastern and eastern Kazakhstan. In each of these mountainous areas, the number of relatives of horticultural crops is around 20. In northern Kazakhstan they are half as much. In the northwest of the Republic, such species are rare. In central and southwestern Kazakhstan, wild relatives of fruit crops are not available. Obviously, the fruit agrobiodiversity in Kazakhstan is mainly associated with the mountain ranges of the south, southeast and east of Kazakhstan.

Alien woody fruit plants grow only in the south and southeast of Kazakhstan in natural ecosystems. Their maximum number (13-14 species) is concentrated in the mountains of the south and southeast of the country, and in east Kazakhstan, the representativeness of the alien fruit species is three times less.

We can thus conclude that the more favorable conditions for fruit plants in the region are, the more densely it is populated by alien woody fruit plants. In favorable environmental conditions, the natural introduction of alien fruit species into the gardens increases. From the gardens, alien fruit plants are successfully naturalized and successfully accommodate to natural ecological systems.

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CONSERVATION AND SUSTAINABLE USE OF PISTACHIO WILD RELATIVES IN CENTRAL ASIA

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In modern times, the range of pistachio's natural habitat is confined to the lowlands of mountain systems of the Tien Shan (northern geographic boundary), the Pamir-Alai Region (central part), and the Kopet Dagh (the southern geographic boundary). It features a fairly large extent of territory—from the Kyrgyz Range running north to south (430 13 latitude north) to the foothills of Paropamiz (350 05 latitude south) and from the Boam Gorge foothills of the Kyrgyz Range (750 45 longitude east) to the southwestern Kopet Dagh (550 04 longitude west) running east to west (Bulichev 1969, Kamelin 1973). According to Popov (Popov 1979), the length of pistachio distribution area from north to south is 800 km, from east to west is about 1300 km. The altitude range of the pistachio habitat is rather wide as well – from 500 to 2000 m above sea level.

The restriction of pistachio stands to certain mountain systems separate from each other, as well as some differences in their climatic conditions, indicate a high ecological adaptation of pistachio to various climatic conditions in the region.

Common pistachio forms a unique florogenetic biocenosis of pure pistachio woodlands. Their structure is characterized by sparse crown layers and tight root systems. The drier the conditions, the less moisture is in the soil, the farther the root system extends into the upper soil horizon, providing the tree with normal growth and development during the dry summer period. It is no wonder that in Badkhyz (Turkmenistan), in the most extreme dry growing conditions for pistachio, tree density is 0.1-0.3 (30-40 trees per hectare), while under more favorable conditions, the number of trees per hectare increases to 70-100 .

Pistachio posses an exceptionally strong resistance to drought and heat and a relatively high resistance to frost, which opens up tremendous prospects for growth in cultivation of the crop on the vast bare rainfed areas at the altitude from 600 to 1400 m above sea level.

Growing in the dry zone of the Central Asian mountains, pistachio with its strong root system protects the slopes from erosion and run-off, and provides a valuable source of highly oleic nuts that have received worldwide recognition. It is no wonder, then, that in the countries of the Middle East pistachio is called

the “golden tree” or “green gold” because of the high income received by the population from the marketing of pistachio nuts.

Forming pure woodlands in nature of Central Asia and being a dioecious plant, pistachio, which is propagated by seeds , is characterized by large intraspecific polymorphism based, above all, on the highest diversity of fruits produced. In nature, and in seed crops, it is virtually impossible to find two trees with identical fruit. Pistachio’s biotype (form) is, in fact, every single tree (individual). Pistachio form diversity, which displays itself in the structure and development of aerial and underground parts of plants, biological productivity, resistance to adverse environmental factors, etc., and in the form and mass of fruits and their qualitative characteristics, offers unlimited possibilities for the selection of domestic (Central Asian) varieties. Some results of the selection of the best forms are listed in the table.

Economic and biological characteristics of the best pistachio forms selected in Uzbekistan	**Mean multiyear data on original parent forms**					
	Fruit weight, g	**Kernel, %**	**Yield of nuts with opened shell**	**Marketable nuts yield, kg/tree**	**Kernel content, %**	
					fat	**sugar**
Pistachios of Babatag, age 100 to 150 years						
518-G	0.83+ -0.03	50+ -0.2	93	2.5	54.2	4.3
521-P	1.16+ -0.04	52+ -0.2	80	3.8	54.9	6.7
527-Sh	1.08+ -0.03	50+ -0.2	92	3.0	64.4	6.1
528-G	0.82+ -0.03	54+ -0.2	95	8.0	55.8	6.4
Seed crops, age 40-45 years						
52-RG	0.95+ -0.02	51+ -0.2	85	3.3	54.1	6.7
50-G	0.95+ -0.02	49+ -0.2	82	2.3	54.9	7.3
5/8	1.18+ -0.03	58+ -0.3	100	2.5	57.1	6.0
5/9	0.90+ -0.02	50+ -0.2	92	8.0	55.5	6.5

At the same time, for many decades natural pistachios were subjected to excessive anthropogenic pressure (grazing, logging, etc.). Negative human factors caused not only sharp (more than 6-7-fold) reduction of the natural distribution area of pistachio, but, above all, the loss of a valuable gene pool of this species created by nature. There are reliable archeological reports (Lisitsina 1972) which show that in prehistoric times the pistachio area in Central Asia occupied two million hectares, while in modern times, unfortunately, it does not exceed 300

hectares. Only on Babatag Ridge (Uzbekistan), the area of natural pistachio has decreased in the past few decades from 70 hectares to 12 hectares.

It should be emphasized that for people living in dry arid foothills, where without irrigation no species can grow, the pistachio has an exceptional importance. Due to its strong root system the pistachio protects arid foothills from washout and erosion during the spring rains, being simultaneously both the land custodian and a land improvement factor.

In addition, since ancient times the people of the East have known the medicinal properties of the high oleic pistachio fruit described by Abu Ali ibn Sina in “Canon of Medicine”.

In recent years the biodiversity of fruit crops and their wild relatives is subjected to genetic erosion, i.e. disappearance of many valuable varieties, forms, and even species.

Assessment of the status of pistachio wild relatives shows that the conservation and replenishment of this species in its native home—Central Asia—is of great importance, and the people who live in this wonderful, beautiful region must protect, rationally use and conserve the unique pistachio forests created by the nature.

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CURRENT STATUS OF WILD CROP RELATIVES IN KYRGYZSTAN

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In the mountains of the Western Tien-Shan there are the largest walnut forests in the world by size and diversity of trees and shrubs,. Walnut, pistachio, almond, apple, pear, plum, hawthorn, grape, buckthorn, black currant, barberry and other fruit and forest species grow in these forests (Lazkov & Sultanova 2011).

The fruit plant species composition diversity of the of Western Tien Shan has much in common with other mountain regions of Central Asia, which is considered the center of origin and storage of a large number of cultivated fruit plants. Many of the ancient local varieties of crops such as walnut, apple, apricot, plum, grapes, pomegranates and almonds, cultivated by local populations in mountainous areas, have a remarkable resemblance to their wild relatives from the mountain forests. Since ancient times, plants with the best fruits have been transferred from the forest closer to human settlements, and have since spread around the world, leading to the origin of cultivars.

The main forest-forming species of Kyrgyzstan is the walnut, which occupies the slopes of Fergana and Chatkal ranges in an area of more than 45 000 hectares (Venglovskiy 2006). This area is a treasury of wild fruit and berry plant species and form diversity. The walnut tree astonishes with its beauty, the variety of crown shape, the size of the giant trunks, shape, and fruit quality. In the forest it is almost impossible to find two trees identical in morphological, biological and economic features.

Among the trees there are specimens that differ in terms of maturity, vegetation period length, winter hardiness, resistance to diseases and pests, timing of flowering of male and female flowers, the regularity of bearing, high yield, ripening, size and quality of fruit.

Since ancient times the walnut has been highly valued and has attracted strong interest for its delicious and nutritious fruit, its medicinal properties, its most valuable and easily treated wood, and the amazingly beautiful trees for landscaping towns and villages. The walnut has long been cultivated throughout the world, but the vast genetic diversity of this species is not being used. The pantry of these genetic resources is a unique, extensive population of walnut – the walnut-fruit forests of the Western Tien-Shan.

Common pistachio (*Pistacea vera* L.) grows in the wild and was introduced into agriculture in the southwestern foothills of the Fergana Range on an area of 36,010 hectares, at an altitude of 700 to 1100-1200 m above sea level. Southern Kyrgyzstan is the northern boundary of the pistachio habitat (Ozolin 1968).

This is the only nuciferous breed that can successfully grow and bear fruit in extremely arid conditions where other species can not grow. Pistachio is mostly valued for its nuts, which have a good taste and nutritional qualities that have received worldwide recognition. Other parts of the tree have been used since ancient times in the manufacture of paints, dyes and tannins, in woodworking and for medicinal purposes. However, the intraspecific diversity in size and kernel quality and such traits as resistance to pests and diseases are not widely used in the selection of pistachios for breeding. Due to its strong root system, the pistachio has a great importance in soil and water conservation. Natural regeneration by seed is hindered by bush felling, grazing and mowing.

Apple trees have a large distribution area and diversity of different forms. In the Western Tien Shan on an area of 16,000 hectares, it forms various types of apple woods. In the forests there are three apple tree varieties. The morphological and ecological characteristics of these species differ significantly:

Kyrgyz apple tree (*Malus kirghisorum* Al. et An. Theod.) A tree up to 12 m in height, the crown is sprawling, and canvaslike. Fruits are greenish-yellow. The distribution area is in the middle belt of walnut-fruit forests at an altitude of 1400-1800 m, forming small independent apple woods in the midst of forests of walnut and other species in the second tier. It is confined to the slopes of northern exposure (Gareev 1971).

Sievers apple tree (*Malus sieversii* M.Roem.) A tree up to 8-10 m in height. In extremely dry conditions it grows in the form of a shrub. The crown is canvaslike and narrow. The fruit color ranges from red to yellow. It is hardy and drought resistant. It is widely spread in the lower zone of the walnut-fruit belt and in the north they form small separate woods or grow in community with other species. The Sievers apple tree is confined to the slopes of the southern, eastern and western orientation at an altitude of 1,200 to 1,800 m.

Niedzwiecki apple tree *(Malus niedzweckiana* Diesk.). The tree height is 6-10 m. The crown is broadly oval; bark is reddish-brown. The unique feature of Niedzwiecki apple is pink and purple pigmentation to varying degrees, showing itself in the color of leaf, flower and fruit. It can be found in walnut-fruit forests of the middle mountain zone, within the range of 1400-1800 m. In apple woods it is very rare.

The fruits of the wild apple trees are very diverse in size, shape, color, taste and terms of maturity. Researchers have noted that the fruits of the above wild apple species have better flavor when compared with other wild apple species, for example in Siberia . Among the huge diversity of apple trees in the forests, there are ones that resemble some of the cultivars. When a general disease contaminate is present in the woods there are trees that are resistant to scab and powdery mildew. They differ also in terms of yielding capacity and terms of maturity. The fruits are used fresh or dried and are suitable for different types of

processing. The trees provide a good rootstock for breeding different varieties of apple trees. Apple is strongly affected by anthropogenic factors, unsystematic felling, uncontrolled grazing, forest fires and lack of forest utilization standards. Natural regeneration is of vegetative origin and the plant is easily grazed down by cattle.

Sogdian plum (*Prunus sogdiana* Vass) is one of the most valuable fruit crops. The highest form diversity of Sogdian cherry plum is observed in the southern Kyrgyzstan, where it grows in abundance in the walnut-fruit forests.In the north, in the Kyrghyz Mountains, its variability is greatly reduced, and is often represented by small-fruited forms. It is widespread and drought-resistant. It features a wide variety of fruit size, shape, color, and taste. In the forest, one can find fruit trees growing close to each other and of yellow, red, burgundy, and black color. The fruits vary in taste from acid to sweet pulp, and vary in consistency from succulent to thick. The local population selects and conserves Sogdian cherry plum for its great variety and the nutritional value of its fruits. The practice of using plum is diverse, and many farmers grow a few trees on their plots. For this purpose, they choose high-yielding trees with the best fruit quality in the woods and plant them on their fenced plots.

The plums are used mostly for processing into jam, paste, dried fruits and harvesting seeds for rootstock. The fruits of the selected sweet forms are also used for fresh consumption and sale on the market. The use of plum as a rootstock for grafting propagation of stone fruit trees, especially plum, apricot and cherry plum cultivars, are very important. The cherry plum bushes are used for firewood. Farmers thin and rejuvenate cherry plum trees in their home orchards, by cutting down their old and died parts. Sustainable reproduction of cherry plum is possible due to the restriction of cattle grazing and the practice of leaving the fruit on the bushes to be spread by birds and other animals.

Wild grapes grow in the forests of the western Tien Shan, in river terraces and canyons and among rocks and thickets of shrubs, or climb around trees in areas with constant moisture, at an altitude of 1500-1800 m above sea level. Grapes belong to the species *Vitis vinifera* L. ssp sativa D.C., or wilding grapes. Externally, wild grapes are not distinguishable from the cultivars. The raceme is long or medium and loose. The berries vary in size, shape, and color. They are mostly small, green, pinkish-red and purple-black. Natural regeneration and propagation occur vegetatively, and by seed spread by birds and animals. In damp places, there is self-sowing of different ages, but very often they are eaten by cattle. The diameter of the trunk at the base of the bush reaches 15-20 cm and the 10-15 m long vines climb high in trees, where there is a fruiting zone, and racemes are subject to being pecked by birds (Shalpykov *et al.* 2007). People eat grapes raw. They are also suitable for the production of dry wines. Wild grape is very valuable for it can be used in breeding for the developing of the new adaptive forms. Especially valuable centers of wild grape natural habitats are found in Jalalabad, in the ravines along the river Naryn, near the town of Tashkumyr. They need to be conserved and included in the specially protected areas. In the village of Razansay the farmer B. Sartmyrzaev supports, conserves and propagates the wild forms of grapes from his and neighboring gorges. Local communities in the

Ferghana Valley and Tajikistan have cultivated grapes since ancient times and wild varieties served as a basis for the development of new, local Central Asian cultivars.

Sea buckthorn is one of the main forest-forming species of floodplain forests. It is very common in the mountainous and highland areas of Kyrgyzstan, forming dense thickets along the river beds and valleys, at an altitude of 800 to 3200 m. above sea level in the places well secured with moisture. It occupies large areas along the coast of Issyk-Kul Lake and in the floodplains of large and small rivers in the region (Malena 1983).

It is very diverse in size and shape of the crown, with slightly prickly shoots, and with berries of different size, shape and color, varying in vitamin and oil content. People use buckthorn for various purposes, but the greatest value lies in its medicinal properties.Berries have a high vitamin mix, and contain carotene, vitamins B1, B2, B9, E, K, C, and trace elements. The sea buckthorn oil is especially valued and widely used in medicine as an antibacterial and wound-healing remedy. Wild sea buckthorn has been introduced into agriculture in Russia, where, based on the selection of the Siberian wild forms, large-fruited and thornless varieties have been obtained. Vast tracts of sea buckthorn in Kyrgyzstan are sources of the most valuable genetic resources, which have not been used to create new varieties of seabuckthorn resistant to local stresses, large-fruited, with high vitamin content and oilseeds . The main threats to the formation and preservation of sea buckthorn populations are overgrazing, mowing and their unauthorized felling in the floodplains of big rivers.

In the mountainous and highland areas of Kyrgyzstan at the altitude of 1500-3000 m above sea level wild currant – Ribes Meyeri grows. In the nuciferous-fruit forests, it can be found on the northern slopes under a canopy of walnut and juniper trees, as well as on the banks of rivers and streams (Shalpykov & Beyshenbekov 2007). Currant is irreplaceable in agriculture for the high-altitude regions and regions with harsh climatic conditions where other fruit cannot grow. Its berries are used raw, or are dried, cooked and used for jam production, as well as being a valuable source of vitamins and other biologically active substances.

Of the six species of currants that grow wild in the mountains of Kyrgyzstan, only black currant had been introduced into agriculture in the Issyk-Kul basin. Its genetic resources have been only partially used for breeding, while other varieties have not been used at all.

Unfortunately, at present this unique genetic diversity is under threat of extinction due to the almost complete lack of natural seed regeneration caused by unauthorized human economic activity, overgrazing and lack of protective and forest regeneration measures. In these circumstances, maintaining the existing diversity in the forests of Kyrgyzstan is of paramount importance for the evolution and development of these forests to provide all user groups, including breeders and researchers, with genetic material.

In Kyrgyzstan in 2006, a major regional project «*In situ*/on farm conservation of agricultural biodiversity (fruit crops and wild fruit spcies) in Central Asia" was launched, in which five Central Asian countries, including Kyrgyzstan, in close cooperation with Bioversity International, have combined their efforts in the

conservation and sustainable use of fruit crops and their wild relatives in the region.

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DIVERSITY OF LOCAL PEACH VARIETIES IN TAJIKISTAN AND ITS USE IN BREEDING

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Peach is a wonderful southern plant. Its fruit is notable for its beauty, delicate flavor and pleasant refreshing taste; they are highly rich in vitamins and minerals. Great varietal and form diversity of this crop ensures a long fresh fruit consumption season, from May to October. Peach originated in China, from where it found its way to the territory of modern Central Asia more than two thousand years ago. Due to the fact that it is easily reproduced by stone, various valuable peach varieties adapted to local conditions were developed through natural and artificial selection. In Tajikistan, there are very common local peach varieties, including winter-hardy, palatable, high-yielding and early maturing ones. This is the achievement of national selection, which has long been practiced by local communities (Venyaminov 1953, Mirzaev *et al.* 1983).

From a range of local peach varieties, frost-tolerant and high quality ones have been selected. National selection has improved the palatability traits of the fruit. Among the local varieties of peaches there are ones with tender, juicy flesh and a harmonic content of sugar and acid. Local folk taxonomy divides the entire assortment of peach varieties according to common traits into nine groups:

Safedak, Ak-shaftalyu. These are peaches with white pulp. They differ from each other in shape, size of fruit and ripening terms, but belong to the same type: fruit with white skin and pulp, without red blush or redness under the skin and with freestone. The flesh is very juicy, sweet-sour, of a pleasant taste. The group is very numerous and is frost resistant. In Hissar Valley they reach maturity in the second half of August. The variety is suitable for dried fruit production. The seed germination rate is high in the Valley; there is a good stock of peach, almond and early plums. This variety has repeatedly been used successfully in breeding.

Surkhak, Kizil shaftolu (red peach). Fruits are pubescent, small or medium-sized, the skin colored with blush of varying intensity. The flesh is white, with redness closer to the stone and often there are fruit with bitter aftertaste. This peach is freestone. The group is very numerous and is mostly frost-resistant. The tree is of medium size, with a spreading crown. Fruit bearing starts in the third or fourth year.

Ravgani gov (cow butter). The original variety of people's selection is widely spread in Ferghana Valley. It is a late season variety; the skin and flesh are yellow, without anthocyanin. It is a table variety, suitable for dry fruit and compote making. It is resistant to diseases. Fruits are medium-sized and are spherical or rounded in shaped. The skin has a rough pubescence, and cannot be removed. The flesh is yellow, moderately juicy or dry, of average sweetness, with a pleasant sour and specific taste and slight aroma.

Anchir shaftolu (fig peaches). Fruits are medium-sized, flat, bulb-shaped, mostly with white, tender, juicy, sweet flesh and a very pleasant taste. However, their disadvantage is the fact that they are unsuitable for transportation and processing. They are strongly affected by fungal diseases at the time of abundant rainfall and high humidity in the spring. The tree is short, with a wide-spreading crown. The skin is slightly pubescent, dense, irremovable, greenish-cream color with a diffuse crimson-carmine blush. The flesh is creamy, juicy, tender fibrous, sweet, almost without acidity, spicy, with slight aroma. The stone is small, can be separated only with difficulty.

Sala shaftolu. Fergana white. A typical representative of the Fergana group peaches, with numerous variations of the seedlings in shape, weight and size of fruit and ripening time. Fruits are large, flattened, with white flesh, of medium size, with a velvety pubescence and freestone. The flowering term is average with a regular yield. This variety is relatively resistant to fungal diseases. The skin is thick, dense, unpeelable, and creamy. The flesh is greenish-white, of medium-density, fibrous, medium juicy, sugary, with a slight aroma, freestone, and pleasant taste.

Kesma, Kyrkma, Cordi (uncuttable). This group includes clingstone peaches with firm flesh and tightly adnate peel. The variety has rare forms, with average frost resistance. The fruit of gristly flesh texture, with rose-type flowers, differs in time of ripening, size and quality. There are two varieties of this type, Kesma white and Kesma late, which are adapted to local conditions, but are unsuitable for preservation; they need to be replaced with more advanced varieties.

*Lyuchak shaftolu***.** These are nectarines, or hairless peaches with thin, shiny skin. The fruits are very diverse in size, shape and color. There can be large-fruited, medium-sized, or small (most often), brightly colored, red and dark red, yellow, white, round, oval, with either removable or irremovable stone (occasionally). The flesh is usually juicy, sweet, has soft consistency, with a little sour taste and strong flavor. It is a table variety, suitable for drying, processing into jam and using for compote. Fruit transportability is average. Trees are easily affected by fungal diseases and peach aphids. Frost resistance is below average, except for the local Red Nectarine form.

Chillagi. This is a small, early maturing group. Fruits are smaller than average, of different shapes and colors. There are Surkh chillagi, with red fruits, and chillagi Safed, with white little sugar fruit. The peel is pubescent and white, while Surkh chillagi has a pink and red blush. The fruits are non-transportable, often with a free or clingstone, and are of round, oval or elongated apex shape. Its frost resistance is average.

Shirindonaki. A small group of peaches with a sweet, edible core. It includes various forms of different maturing terms, with fruit different in shape, velvety and smooth skin (nectarines) (Smirnov 1972).

As a result of long-term breeding involving valuable local varieties of peach at the Institute of Horticulture and Vegetable production TAAS, winter-hardy varieties of peach Guldor, Sumbuli, Ozoda, Ravshan and Zarnigor have been developed and released. The Variety Testing Commission has adopted high-quality, late-flowering nectarines Lal and Nurafshon. New varieties enlarged and enriched the assortment of peach in Tajikistan (Skorokhod & Shamuradova 1982).

The genebank collection includes the gene pool of complex resistance of peach to fungal diseases, donors of late flowering, increased winter hardiness, early maturity and regular and high yield (Shamuradova 1987).

To maintain and replenish the genebank with valuable accessions stock of peach, peach collections were established on the premises of Sumbula farm in Hissar district, at the National Republican Genetic Resources Center (Jamoat Sarikishty Rudaki), on the plot of State Variety Testing in Kabadian area. In the period from 2007 to 2009, about 120 peach seedlings of the fruit-bearing stage and of local origin had been transferred to two farms (Ozodizanon plot, Rudaki district).

In the nurseries, rootstocks are grafted and seedlings are grown, providing standard purebred peach seedlings - a total of 50 accessions of local origin for the laying of matricular graftings garden and planting in private farms. These activities will expand the plantings of peach in the Hissar Valley, Tajikistan and allow an annual high yield of good quality fruit.

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APRICOT CULTIVATION ENVIRONMENT AND BREEDING OUTCOMES IN TAJIKISTAN

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Conservation of agrobiodiversity, which includes the surveying of habitats and the description of forms, varieties, clones and hybrids, is a matter of great importance. Conservation activities involve comparative evaluation and further utilization in the gardens of the farmers, tenants, local communities, as well as in experimental plots in the collection plantations of research institutions. This latter activity allows conserving a great variety of species and varieties of fruit crops, including apricot, for future generations. The apricot is widespread in Tajikistan and has been cultivated here for thousands of years. Its fruit has an excellent taste, a specific fine aroma, a high content of sugar, vitamins, carotene, potassium, magnesium and iron, and therefore is in great demand. Dried fruit for the most part retains all the basic valuable nutritional properties of the fresh fruit. Boboi and Kandak varieties are especially valued in dry fruit production for their supreme quality.

Like any crop, apricot has some drawbacks. The most serious of these drawbacks are poor winter hardiness of fruit buds, early flowering and lack of resistance to fungal diseases of the majority of local varieties.

Almost all climatic zones exist in Tajikistan, from subtropical to the eternal snow of highlands. There are many areas where natural conditions are quite suitable for cultivation of all apricot variety groups. So here it is possible to select suitable areas for the cultivation of every apricot cultivar group, from dry fruit varieties in arid zones to table varieties in the more humid and cool areas, while giving preference to local varieties.

Meteorological data during the apricot flowering phase were used to examine the probability of yield conservation in the areas of Hissar, Vakhsh and Rasht Valleys compared with the traditional cultivation area of apricots in Khujand (Table 1). It was determined that there is some dependence of the yield on height above sea level. In the transition zone (at the altitude of 1200 - 1350 m) the probability of cold weather return during flowering is dramatically reduced as compared to the zone of constant winter (at the altitude of 1350m and above).

Favorable climatic conditions are found in the southern arid areas of Khatlon Region, especially in Shaartuz and Pyanj areas where the climate is dry in spring and summer. In these areas apricot does not freeze in winter, rarely suffers from late frosts, and the warm spring and early summer provide the earliest ripening (usually in the second half of May - early June).

Table 1: Terms of apricot flowering and yield survival capacity, %.

Location of meteorological station	Altitude above sea level, m	Date of frost (Mean multiyeardata)	Probability of frost during flowering season (average %)	Flowers and yield survival capacity, %
Khudjand	410	28 March	30	85
Shaartuz	379	8 March	48	76
Shahrinau	852	21 March	26	78
Fayzabad	1215	6 April	20	92
Obi-Garm	1387	16 April	20	93
Djirgital	1800	28 April	12	95

The earliest varieties (Samarkand early) in the low foothills mature in early May. Demonstration of this fact is seen in the mass cultivation of apricot in the gardens of southern Tajikistan. At the present time in Dushanbe and the surrounding communities apricots are delivered from the far south of the country.

Repeated attempts to grow apricots in the Hissar valley produced no results, because its flowers and ovaries perish after late spring frosts, and the trees suffer from fungal diseases affecting stone fruit crops in areas with a humid spring and early summer. Meanwhile, it was found that there are some places not far from Dushanbe where natural conditions allow growing this valuable crop with a guaranteed yield for 7-8 years out of 10. Such tracts are on the slopes of Hissar, Vahdat, Rudaki and Faizabad Districts, mostly on non-irrigated lands. Here, one can still find individually growing apricot trees (Minbatma village, Chormazak pass), and small gardens. According to longtime residents of these places, the heights of Zardolu on the way to Nurek got its name due to the fact that until the 1930s there were large stands of regularly fruiting apricot trees. Spring weather conditions

in the lowlands of the valley and adjacent slopes of the ridges are different. The higher up in the mountains, the later come the warm days with suitable for apricot flowering temperatures. In central and southern Tajikistan, the average long-term dates of flowering are delayed by three days for every 100 meters of altitude.

Thus, at an altitude of 400 m in Shaartuz, the average flowering date of apricot is 8 March, and in Varzob at an altitude of 1430 m above sea level flowering occurs one month later (April 9-10). In Jirgital at an altitude of 1800 m. apricot flowering begins in late April (April 28), thus avoiding late frosts. Such conditions are also found in the foothills of Hissar and Rasht Valleys and in the highlands from 1300 to nearly 2000 m above sea level. The climate here, in comparison with the low-lying part of the valley, is characterized by spring one month later, which sharply reduces the possibility of flowers getting affected by late spring frosts.

Table 2: Apricot's average flowering and maturing dates and environmental conditions

Meteorological station	Altitude above sea level, m	Average date of last frost	Average daily temp. C	Decade amount of rainfall (mm) in the flowering season	Flowering season begins	Date of fruit maturing
Khodjand	410	19 March	12.4	7.0	28 March	12 June
Isfara	847	29 March	12.1	5	30 March	29 June
Ura-Tyube	1004	3April	10.6	27	4 April	
Tangi-Voruh	1311	6 April	11.4	7	8 April	18 June
Pandjikent	988	2 April	10.0	20	25 March	22 June
Sangiston	1522	1 April	10.7	12	2 April	
Shaartuz	379	11 March	11.1	-	8 March	4 June
Sarband	445	14 March	11.2	16	14 March	6 June
Dushanbe (agr. weather station)	803	21 March	10.2	40	17 March	13 June
Shahrinau	852	22 March	10.3	41	21 March	20 June
Fayzabad	1215	24 March	11.9	57	6 April	30 June
Obi-Garm	1387	2 March	11.5	42	16June	15 July
Kalaya-Khumb	1284	14 March	14.3	24	10 April	8 July
Muminabad	1193	4 April	10.9	53	31 March	25 June

Table 2 cites data on the climatic weather conditions during apricot flowering, showing that the main factors influencing the yield of traditional varieties in the foothill and mountain areas are rainfall and fruit-set.

The most arid areas are Khujand, Isfara, Aini and Shaartuz, where during the flowering period of ten days, there are 5-12 mm of precipitation. In more humid areas (Pyanjikent, Istaravshan, Dushanbe), with rainfall of 20-40mm per decade of flowering phase, the crop yield is very unstable due to the development of fungal diseases and poor pollination, as well as a decrease in temperature during flowering by 1-2 degrees compared with areas of a more successful crop. However, the data from our experiments shows that in high humidity conditions the most suitable for cultivation are local varieties of the Hissar-Zarafshan group (Falgar, Gulyungi lyuchak, Samarkand early, Ruhi javoni surh), as well as varieties of European origin .

A survey of apricot plantations in 2003 in the areas of Central Tajikistan shows that repeated spring frosts, observed in March and April, caused the destruction of flowers and ovaries in the majority of seedlings and varieties (85-98%). In addition, heavy rainfall during flowering and fruit-set instigated a severe attack of shoots, leaves and young growth by fungal diseases (shot-hole disease, shoot wilt of apricot). Only in late flowering local seedlings that are more immune to fungus diseases was fruit bearing in the range of 4.0-4.5 points (on a 5 point scale), and some were up to 5 points.

In the north of Tajikistan, in Sugd province, apricots have been traditionally cultivated for a long time. Here, this crop is an important source of income for local population. In the Sogd branch of the Institute of Horticulture and Vegetable Production, new varieties of apricot that exceed released ones in yielding capacity, fruit quality and disease resistance have been developed by means of selection. They can successfully enlarge and improve the existing assortment and are currently undergoing extensive field-testing.

Release of such varieties in the future will allow a significantly improvement of orchard productivity and an increase in the gross yield of this most valuable crop. Below is a brief description of these apricot varieties.

- *Shirpayvand* is the earliest table-grade variety. Fruits are medium-sized, weighing 20-25g, yield and fruit quality is high. The tree is of medium height, forms a densely leafy, wide pyramide-like crown. Its specific feature is high shoot-forming ability. Fruits are loosely held on the branches and are shed in strong wind. The leaves are medium sized, of an audacious elongated oval shape with pronounced edges. The leaf plate is thick, dense, dark green in color with a characteristic top end, very reminiscent of the East Asian apricot leaf shape. Shirpayvand is the most cold-tolerant variety, also tolerant to sharp thermal fluctuations in late winter. It is considered to be one of the best early maturing table varieties (late May - early June).
- *Shisha Hurmoi* – a mid-season variety of people's selection. The tree is tall. The crown is dense, of wide-pyramidal shape, average leaf density. The fruits are quite large, egg-shaped with a gradually pointed apex. The ventral suture is broad, sharply defined. The peel is thick, pubescent; of a pale orange color with a faint, rosy-red fuzzy blush. The pulp is light orange/dark yellow in color,

of medium consistency and richness, sweet, with a slight aroma. Tasting assessment is 4.8 points. The stone is large, well separated from the pulp. The fruit do not ripen simultaneously and are well attached to the branch. When ripe, they may stay on the tree and gradually dry out. Annual yield capacity is high. Storability and transportability of under-ripe fruit is good. The variety is relatively resistant to shot-hole disease and apricot shoot wilt. The fruit are of universal use, suitable for the manufacture of very high-quality products (juices, jams, purees, compotes). The tree is very demanding in its growth conditions, grows well, and bears fruit in fertile, irrigated land, protected from cold winds. Frost tolerance is high and the tree comes into fruition in the fifth or sixth year after planting. Best pollinators are Hurmoi and Isfarak varieties.

- *Krutak* variety – its late flowering form, 10 - Daravshak, is found in the "October" farm, Isfara district. It is a dried fruit variety, mid-season, frost-tolerant and highly resistant to shot-hole desease. Trees are tall, with a spreading, drooping, lush crown. Fruit bearing starts in the seventh year and at the age of nine the crop yield is 87.0 t/ha. The fruits are round, 36.0 x 32.0 mm in size, orange-yellow, slightly pubescent, with an average weight of 18-22g. The flesh is orange, juicy and thick, with a dry matter content of 22%, sugar content of 17.3%, acid content of 0.8%, pectin content of 0.47%, 1.45% content carotene and vitamin C at 26.3mg%. The tasting score is 4.4 points. The stone is average by size, roughly 25 x 19 x 12 mm, weighing 0.8g, which makes 10% of fruit weight. Transportability of the fruit is good. After drying, the output of finished product equals 26.5-30% of the weight of fresh fruit.
- *Leninabad* variety (clone 3/1 of Kadu Hurmoi variety), found in Isfara district. The fruits are bigger than average (40.3 x 37.2 x 38.9 mm), weighing 36-42g, ovate/egg-shaped, with rounded apex and a small indentation at the base. The peel of the fruit is firm, slightly pubescent, glossy, and orange, without blush. Flesh is orange, of medium density and juiciness. Sugar content of the pulp is high, 14.0 to 16.2%, and the flavor is slight. The apricot yield is 21-26%. The stone is medium sized at 30.0 x 23.1h 12.3mg, oval, pointed at the top and bottom. The ventral suture is narrow, short, the central edge is sharp, there are grooves instead of small holes. The surface of the stone is almost smooth, slightly wrinkled below; the kernel is sweet with lateral edges. The dorsal suture is sometimes closed. The leaves are medium-sized at 30 x 40mm, oval-ovate, gradually tapering to the top. The leaf base is flat, with small indentations. Leaf plate is curved downwards. The stalk is long at 30 - 40 mm, glands are dark brown. The tree starts bearing fruit at the age of 13 to 15 years, producing 60-90 kg per tree, or 130-150 c/ha. Transportability is very good, and this variety is highly resistant to shot-hole disease. The fruit are of universal use. The variety was released in 2006.
- *Olimi* variety (the clone of Niyozi Surh variety). It was found on the "Leningrad" farm of Konibadam district. The fruit is smaller than average (29.0 x 30.0 x 32.0 mm), weighing 18.2-20.0 and of blunt shape, with indented apex. The ventral suture is very shallow. The flesh is light orange, tender, juicy, very sugary, with little acid and slight flavor. The taste of the fruit is very good (4.0 points out

of 5), the fresh fruit contains 18.2% sugar and 0.78% acid. Apricot output is 26-30%. The stone is small at 21.0 x 18.3 x 105 mm, weighing 1.62 grams, is not equilateral, has an ovate-acuminate shape with a strongly drawn, pointed apex and considerably utricular sides. The ventral suture is of medium width, the central rib is sharp. The dorsal suture is closed, has relatively few small holes. The surface is smooth, the shell is thin, the kernel is sweet. The leaves are of medium size, 50x 60mm, broadly oval, with acute apex. The leaf's foundation is flat, the plate is bent down, and the edges are serrate. The petiole is short, up to 40mm, with 2-4 glands. The tree is of medium height with a flat-spreading crown. Annual yield is high; at the age of 13-15 years the yield is 55.0-70.0 kg per tree or 110-140 c/ha. The fruits are suitable for fresh consumption and are transportable. Fruit mature simultaneously and are well attached to the branches.

- *Tadzhiboi Luczak* variety (clone of Tadzhiboi variety) was found in Isfara district. Fruits are of medium size, 36 x 34 x 33 mm, with a weight of approximately 22g. They are of broad oval shape and laterally compressed. The ventral suture is well marked. The main color of the peel is pale yellow, with a gentle carmine red glow. The flesh is firm, creamy-yellow, with a pronounced sweetness and moderate acidity. The stone is small, of medium weight, 1.7g, well separated from the pulp. The core is sweet. The quality of dried products is high. The edges of the leaf are serrulate, of medium size (30 x 40 mm); the leaves are oval-ovate, shortly acuminate to the top. Leaf plate is bent down. The petioles are long at 30-40mm. The tree is tall, with a rounded prostrate crown. It starts bearing fruit early. The time of fruit ripening is the second and third decade of July, and the variety is late maturing. The yield is high and annual; at the age of 13 to 16 years the harvest is 50 - 60 kg per tree, or an average of 137 c/ha. The fruits ripen at the same time and are very tightly held when dried on the tree. The variety is transportable, versatile, suitable for drying and processing into compotes, jam, etc. Its disease resistance is average.
- *Khujandi* variety was found on the Kuybishev farm of Isfara district. The fruits are smaller than average (33.4 x 20.4 mm), weight is 16.6g, shape is broad oval or wide round-ovate. The ventral suture is narrow. The skin is thin, not firm, and yellow. The flesh is yellow, of medium density, tender and fibrous. The sugar content of the pulp is high, with medium acidity and weak flavor. Tasting assessment is 4.3 points, apricot output is 28.0 to 30.4%. When dried the fruit does not take on a candy consistency. The stone is average (23.7 x 15.1 x 9.4 mm), its weight is 1.7g, the shape is sharply ovoid and well executed. The ventral suture is narrow, with only the central ridge well defined. The dorsal suture is normally open at the bottom. The surface of the stone is rough, easily wrinkled on the bottom and the kernel is sweet. The leaves are medium-sized (65 x 60 mm), broad oval, with a gradual transition to a short pointed top. The leaf bottom is flat, sometimes with a hollow. The leaf plate is glabrous on the upper side, and with fluffy grooves on the backside. The petiole is of medium length (30 - 33mm). Trees are tall, perennial and start to bear fruit early. Annual yield is abundant and at the age of 13-15 years it is 70-80 kg per tree or 140-160 c/ha. The fruit ripen simultaneously; they are

well kept on the tree, can dry out there, and are transportable. Its resistance to shoot hole disease is average. The fruit is of universal use. The variety was released in the Republic in 2006.

Thus, the survey of the apricot orchards' status in recent years makes it possible to form the following conclusions:

- The southern areas of the Vakhsh and Kofarnikhon Valleys are very favorable for the cultivation of local and imported apricot varieties (Leninabad, Arzomi katta, Ahror, Ahmadi, Samarkand early, Kandak, Bobo, etc.). There is a possibility for establishing a depot for the export of early stone crops (apricot, peach and plum early) fresh produce to Russia and northern Kazakhstan.
- Climatic conditions of central Tajikistan are unfavorable for the cultivation of traditional apricot varieties such as Zarafshan and Sugd groups. These areas may specialize in the cultivation of local apricot forms and resistant varieties from other regions.
- Long-term multiplication of apricot by seeds in Hissar and Rasht districts contributed to the emergence of seedlings with resistance to adverse conditions (frost, heavy rainfall during flowering season), late flowering and immunity to fungal diseases , although the result is often fruit of low quality. Possessing late flowering and disease resistance genes, they are a valuable initial material (donors) for breeding and need to be preserved and studied.

The survey of orchards and selection of the best forms and clone varieties of apricot in Sogd province made it possible to identify a number of high-yielding varieties that are resistant to adverse environmental factors, with high-quality fruits. Their use is recommended for general industrial testing. As a result of the breeding works with using local diversity of apricot conducted in the Sogd branch of the Tajik Institute of Horticulture and Vegetables in recent decades, four varieties of apricot have been submitted to the Variety Testing Commission, two of which - Khujandi and Leninabad varieties—were released in Tajikistan in 2006.

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VARIETY STUDY OF THE GRAPE COLLECTION OF THE KYRGYZ RESEARCH INSTITUTE OF FARMING: CONSERVATION AND DISSEMINATION OF THE BEST VARIETIES AMONG FARMERS

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The grapevine is a very ancient crop known and cultivated by people since ancient times. Fossil remains of grape leaves and seeds indicate that it appeared in the Tertiary period of the Earth's geological history. Grape's introduction to agriculture occurred over a long period.

Through centuries-old practices, people have created a diverse assortment of grapes; there are over 10,000 varieties (Pelyah 1974) that are only mentioned and described in the literature. The total number of grape varieties in the world is more than 20,000 (Stoev 1981).

Viticulture in Kyrgyzstan has its roots in very remote times during the Sogdian culture of the fourth through tenth centuries. In the archaeological excavation of buildings belonging to the eleventh century, a wine making facility was found, pointing to the antiquity of not only viticulture but also wine making in Kyrgyzstan.

Contemporary viticulture in Kyrgyzstan has arisen in connection with the settlement of certain areas by migrants from other regions with developed viticulture. In the northern part of Kyrgyzstan (Pishpek area) grapes were introduced in 1880-1885 by the horticulturist A.M. Fetisov (Sosina 1971). After Moldovans to Semirechye in 1900 from Bessarabia, grapes have become more common. Immigrants from Uzbekistan introduced grapes in Tokmak. The settlers, who knew and loved grapes, promoted cultivation of this crop. Due to the closeness of Uzbekistan and Tajikistan, grapes also emerged and spread in the south of Kyrgyzstan.

Viticulture is a highly profitable industry in agriculture. If the right agrotechnique is applied, grapes give high and stable yields—up to 25 tons per 1 ha. However, the laying of new plantings requires large capital investments and significant labor costs, which in today's economy of Kyrgyzstan does not allow the viticulture industry to develop steadily. In general, except for a few relatively large farms, only small farms are engaged in grape production in the country. Of particular importance is the location of these farms in the complex mountainous terrain of Kyrgyzstan.

The grape yield, along with its improved cultivation technology, largely depends on variety. As the only academic institution of the Republic engaged in

breeding and variety study of grape, the Kyrghyz Research Institute of Agriculture since its inception in 1937 has gathered a collection of grape varieties and studied their local environment in order to select the best economically valuable varieties that meet the diverse soil and climatic conditions of the country (Bebneva 2011). Over these years, an extensive collection of varieties had been created. According to the grape variety study, many of the developed grape varieties have been suggested for release in the territory of the Republic.

These are such economically valuable varieties as Nimrang, Taifi pink, black Kishmish, Rizamat, Soviet, Pobeda, Kara dzhandzhal, Ala-Too, Guzal Kara, Madeleine Muscat, Uzbekistan Muscat and many others which are widespread in the country (Sosina 1957). At this stage, the most productive, the most resistant to adverse environmental conditions and varieties with attractive appearance of racemes and berries of high quality are being selected. The best of the studied varieties are suggested for release.

In the Chuy Valley, many of the respondent farmers surveyed within the framework of the project "*In situ*/on farm conservation and use of agro-biodiversity (fruit crops and wild fruit species) in Central Asia," received new grape varieties for their sites from the collection of Kyrghyz Research Institute of Agriculture. The studies were conducted in the parent vineyard on the "Yntymak" farm, located in the foothills of the Chuy Valley at an altitude of 920 m above sea level.

The soils of the site are northern ordinary gray soils. At shallow depths (60-100 cm), they transform into stony-pebbly deposits. Ground water is more than 20 m below the surface. In the collection area for variety testing in 1990-1994, 152 varieties were planted, including 23 of the Kyrghyz Research Institute of Agriculture breeding. Observations and surveys were conducted on 50 new introduced varieties.

The vineyards are irrigated, self-rooted and uncovered. The scheme of planting is 3.0 x 1.75 m. The training system of bushes is in vertical trellis, the bush-forming system is multi branch and fan shaped and agronomical practices are common ones.

The study of the winter hardiness and yielding capacity of grape varieties showed that the loss of buds after overwintering in the open air (2009-2010) in many introduced varieties (Dzhandzhal Kara, Parkent rozoviy, Ichkimar, Kishmish Zarafshan, Volga-Don, Mirniy) was 35-40%.

The most resistant varieties are the ones developed in Kyrgyz Research Institute of Crop Husbandry (Kyrgyzskiy ranniy, Madlen muskatniy, Tan-Zaar, Frunzenskiy ranniy, Kishmish Chuyskiy, Mayram, Chuy, Olga), and introduced varieties that suffered the least without plant protector (10-15% loss of buds) were Muromets, Pervenets Saratova, Volzhanin, Rubtsovskiy, Codryanka, Moldova, Guzal kara, Kurbain Boshi, Djura uzyum, Velikan, Andijan cherniy. The earliest flowering varieties and hybrids are Muromets, Muscat sverhranniy, Pervenets Saratova, Muscat plevenskiy, Iyulskiy, Cherniy bessemyanniy (Black seedless) and Tukai with start of flowering on June 13-14.

The majority of varieties and hybrids start flowering in the period June 15-18. Late flowering (June 19-21) varieties include: Codryanka, Moldova, Pozdniy VIRa. The duration of the flowering phase is 8-11 days, depending on the variety.

High shoot fertility (0.7-1.2) was observed with the following varieties: Pervenets Saratova, Alma-Ata, Muromets, Kyrgyzskiy ranniy (standard), Moldova, Kodryanka, Muscat Tairova, Jura uzyum, Guzal kara, Tukai, Muscat plevenskiy, Muscat kachunskiy and U-95-22.

Timing of maturation varies. Early varieties and hybrids (Codryanka, Muscat beliy sverhranniy Pervenets Saratova, Muromets, Kirgyzskiy ranniy begin to ripen on 7-10 July; mid-season varieties (which are most of the varieties) begin maturing on 8-13 August and late varieties and hybrids (Guzal kara, Gau kara, Kishmish Sogdiana) begin to mature 19-22 August. The ripening phase in the Chui Valley, from the beginning of ripening to full maturity, requires 25-30 days, depending on the variety.

Yielding. The highest yielding varieties are the ones most resistant to pests and diseases, with a high rate of fruiting. On the introduced varieties testing site, the highest yield was obtained from the following varieties: Kodryanka 14.5; Guzal kara 10.9; Pervenets Saratova 10.3; Djura uzyum 9.6; Moldova and Velikan 9.8; Alma-Ata 9.7; and U-95-22-9.5 tons/ha. The yielding obtained from the singled out varieties significantly exceeded that of standard ones: Kyrgyz early 9.2, Senso 5.9, Karaburnu 8.7 tons/ha.

By mean weight (g) of racemes, the varieties were classified as follows: Gau kara, Rizamat and Kishmish Sogdiana – 250 g; Guzal kara – 220 g; Soviet and Kalayzak – 200 g; Alma-Ata – 195 g; and Kodryanka – 190 g. According to the data obtained in Kyrgyz Research Institute of Crops Husbandry, the following varieties can be recommended for growing without plant-protecting shelter on the farm and homeyardss: Kodryanka, Guzal kara, Pervenets Saratova, Djura uzyum. For the best harvest under winter shelter the following varieties have been recommended: Gau kara, Rizamat, Kishmish Sogdiana, Sovetskiy, Kalayzak and Alma-Ata. Proper selection of cultivars, and ensuring that they are cultivated locations in accordance with their biological characteristics, will contribute to the increase of grape yield and quality of marketable products.

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PROMISING PISTACHIO LINES OF BADKHYZ RESERVE FOR FURTHER VARIETY BREEDING

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Pistachio (*Pistacia vera* L.), a valuable wild plant that grows in the foothills and mountainous regions of Turkmenistan, is of great interest to the national economy. In the course of human economic activities, the area of pistachio's natural habitat has been greatly reduced. Individual groves are found in east, central and southwest Kopetdag, as well as in the mountains of Kugitang. The main arrays of pistachios, as standards of forest communities, are in the south of Turkmenistan in Badkhyz, which is the monticulate area of the Parapamiz foothills. The part of the Hindu Kush mountain system in Afghanistan. Kushkinsk grove is located to the east of Valley Kushka and Pulhatumsk grove is 120 km to the west of the same valley. Their total area is about 75 thousand hectares. Populations of pistachio groves still have a huge gene pool for the selection of valuable large-fruited forms, resistant to pests, diseases and tolerant of dry winds.

Pistachios are an essential food and raw material for food, medical, pharmaceutical, and other industries. The demand for pistachio in the world market is always much higher than raw material supplies. Countries that pay great attention to the study and cultivation of pistachios enjoy high returns. The introduction of pistachio into agriculture was implemented on the basis of irrigated and rainfed agriculture. At the same time horticulturists have been constantly searching for and selecting for breeding large-fruited forms of pistachios with a stable high yield and other valuable features, the use of which is not limited to reforestation, but also as the basis of high-quality crops on plantations to produce valuable products.

In Turkmenistan, the homeland of pistachios and its rich gene pool, little attention has been paid to date to the selection and study of local advanced varieties to put them into production. The first studies in this direction were initiated in the 1960s-1970s in natural stands of Kushkinsk and Badhyz groves. As a result, the varieties which could serve as the initial gene pool for breeding of domestic crops were selected, but these studies did not receive further

development and were lost (Kabulov 1971). However, they showed that there are lines which, according to their economic/biological characteristics are similar to the foreign varieties. The study of advanced forms of pistachios in order to obtain sustainable local varieties will accelerate the development of pistachio growing, and save the precious natural pistachios biodiversity in the country.

In the first stage of our work, we had the following objectives: selection of the most valuable lines in economic terms for the breeding of local varieties in pistachio stands of Badkhyz and the study of their biological characteristics.

Studies on the selection of pistachios should include examination of the following main economic and biological characteristics: high and stable yield, size of nut, its openability, and the shell slit width, its color, disease resistance, and dry wind tolerance.

The search for and description of promising pistachio lines in the Badkhyz nursery was conducted within the framework of the project "*In situ*/on farm conservation and use of agro-biodiversity in Central Asia" in the period 2006-2007. The total area that was surveyed in Badkhyz nursery equaled approximately 2,300 hectares. The basis for the assessment method using biological indicators of environmental parameters was the descriptor developed by the International Institute for Plant Genetic Resources (now Bioversity International).

In the course of the survey, 37 trees, the fruit of which had been of the greatest interest, were identified and described. The plants were of various ages: 12 were young, 5 middle-aged and 19 were old. It should be noted that the viability of the older individual trees was satisfactory. Analysis of the drupe parameters showed that the length of nuts ranges from 1.64 to 2.11 cm and their width from 0.8 to 1.3 cm. Shell openness of pistachio nuts in the studied varieties was graded, resulting in three percent at <40, eleven percent at <60, fourteen percent at <80 and seventy-two percent at >80. The weight of 100 kernels ranges from 37 to 54 g.

The analysis of material by their eco- biological and economic traits for the two years permitted the identification of only 11 lines out of 37 samples, (#4, 7, 8, 9, 10, 14, 17, 19, 26, 37, 29), which met the main requirements for promising pistachio lines. Some parameters are given in Table 1. The average length of nut in these lines varies from 1.8 to 2.0 cm. Width of nut is in the range of 1.0-1.2 cm. Shell openness of nuts is 71-98%. Weight of 100 kernels - 39-49 g.

Studies showed that selected pistachio lines, although they have smaller nuts than the best lines of Iranian origin (Apsheron, Azerbaijan), are not inferior in terms of other parameters, such as kernel output, nut openess, fruitening sustainability.

The selection of promising pistachio lines in natural habitats, based on several years of research (on biological and economic characteristics) will accelerate the development of local resistant varieties (Chernova 1994).

The actual pistachio yielding is much less than its potential one (Chernova 1994, Enkova 1970, Aleksandrovskiy 1978, Popov 1976, Popov 1979, Chernova 2004). In order to identify factors affecting the yield of the studied forms, we conducted observations in the period between flowering and the formation of ovaries, as well as during the formation of the kernels in the nuts. During the formation of ovaries, and then after 10-15 days, observations of kernel formation were made and preserved nuts were counted.

Table: Characteristics of nuts of promising pistachio lines

Number of the sample	Number of opened nuts, %	Weight of 100 nuts, g	Weight of 100 kernels, g	Length of nut, cm	Width of nut, cm	Length of kernel, cm	Width of kernel, cm
7	98	88.0	49.1	1.8	1.1	1.67	0.84
8	75	87.2	47.0	1.9	1.0	1.72	0.90
29	98	79.4	44.3	2.0	1.0	1.66	0.88
37	95	88.6	47.9	1.8	1.0	1.60	0.89
17	88	80.6	38.8	2.0	1.0	1.51	0.81
26	88	79.4	43.3	1.8	1.0	1.61	0.89
9	92	91.4	47.1	2.0	1.1	1.64	0.87
10	79	83.4	44.1	1.7	1.1	1.45	0.91
14	71	79.8	39.1	2.0	1.1	1.65	0.78
19	94	89.6	48.7	1.8	1.0	1.5	0.88
4	80	102.9	49.9	1.8	1.2	1.61	0.94

The fruits of the studied promising pistachio forms in nature

As the records of results show, the ratio of formed ovaries to the flowers in the inflorescence in 11 studied lines, was 60-90% by the end of flowering. Throughout the period of fruit formation, dying off and abscission of formed ovaries occurs

and fruit get damaged by dry winds, pests and diseases. Based on two years of research, three periods of pistachio yield loss were identified.

Perhaps further studies will update this data. In the first period, the second decade of May in 2008, the formed ovaries' dying off ratio was 58-94%. Significant dying off is observed, probably due to insufficient pollination and pest damage of the ovaries. In the second period, abscission was observed due to surges of high temperatures as a result of hot winds, causing burning of immature pistachio nuts.

The third period of abscission occurred due to pests and fungal diseases emerged in the inflorescence. Consequently, by the time of the crop harvest in August, the studied lines retained 3-35% of good quality nuts out of formed ovaries, and on average about 15%.

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SELECTION OF FRUIT CROPS FOR ORCHARDS ON LEASED AND HOUSEHOLD PLOTS

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When establishing an orchard, special attention should be paid to the selection of fruit crop varieties. Varietal composition of plantations is determined primarily by taking into account the requirements of horticulture and fruit species adaptability to soil and climatic conditions. In order to establish an orchard it is important to select varieties of different maturity terms, of early fruit bearing, steady yields, high fruit quality and resistance to diseases and pests. In addition, varieties must have small-sized trees, making it easy to care for plants, but strictly adhere to the released varieties recommended for the area.

The ratio of fruit trees in the garden depends on growing conditions. For Kopetdag and Sredneamudarinsk subzone, the ratio of fruit trees in the orchards is recommended as follows: pome (apple, pear, quince) 35%, stone (plum, cherry plum, apricot, peach, cherry) 60% and sub-tropical 5%.

In the sub-tropical zones of Balkan province, the planting of olives, pomegranates, figs, persimmons and almonds should be increased by 60%, at the expense of pome and stone fruit crop reduction. Of the stone fruit crops, more area should be given to the peach, apricot, and plum cultivars that are suitable for drying.

In Dashovuz Province large areas should be given to the cultivation of apple, pear, apricot and plum trees. This zone has favorable conditions for growing the “Delicious” apple variety with intense color. Apricot and plum varieties suitable for drying give high annual yield due to their late flowering period when the spring frosts are finished.

*Space arrangement of species and varieties***.** Trees of different species and varieties should be planted so that the most demanding ones can be placed under the best conditions. The most fertile areas, with sure moisture and protection from wind should be used for planting demanding autumn and winter varieties of apples and pears, as well as plums, apple and pear varieties on dwarf rootstocks. Areas with loose, aerated and moisture-rich soil are recommended for cherry and peach cultivation. Apricot is relatively drought-resistant and extremely undemanding with regard to soil conditions; it can be grown in any area, but the best are still the sabulous or irrigated, gray desert soils of aggregate size distribution, having moisture capacity and low salinity.

When planting trees of various species it should be taken into account that all varieties of apples, pears, cherries, some plums, sweet cherries, and apricots are

autosterile cross-pollinated plants. They have to be pollinated by other varieties – otherwise, they give low yields.

All peach varieties and some varieties of apricots, plums and cherries belong to the self-pollinating crops, although even in this case, the joint planting of several simultaneously flowering varieties significantly increases the yield.

For the best inter-pollination, strip of trees of the same varieties are alternated with strip of pollinator tree variety. After every 10-15 rows of the main varieties there should be one or two pollinator variety rows. Mono-variety stripes are approximately 50 cm in width. On every site, there should be at least three and no more than five varieties in order to ensure better pollination. Pollinated varieties and variety pollinators should bloom and come into fruition at the same time; it is desirable that the length of the growing season and especially the fruit-maturing phases coincide.

One variety of a single maturation time is planted in each compartment. For example, summer varieties are planted on one site, autumn on the second, winter on the third.

The table cites the recommended varieties for planting and pollination:

Recommended varieties for planting and pollination

Main varieties	Pollinator varieties
APPLE TREE	APPLE TREE
Pskentskoye	Borovinka Tashkentskaya
Khasildar	Pskentskoye, Borovinka Tashkentskaya
Saratoni	Borovinka Tashkentskaya, Khasildar
Borovinka Tashkentskaya	Pskentskoye, Khasildar
Earlyblize	Starcrimson, Rennet Simirenko
Golden delicious	Rennet Simirenko, Starcrimson
Rennet Simirenko	Borovinka Tashkentskaya, Golden delicious
Starcrimson	Golden delicious, Rennet Simirenko
PEAR TREE	PEAR TREE
Lesnaya krasavitsa	Olivier de Serres, Lyubimitsa Klappa (Klapp's favourite)
Lyubimitsa Klappa (Klapp's favourite)	Lesnaya krasavitsa , Beurre Giffar
Cure	Lyubimitsa Klappa (Klapp's favourite)

APRICOT TREE	APRICOT TREE
Ruhi Djuvanon	Subhani, Kursadik
Arzami	Khurmai, Yubileyniy Navoi
Komsomolets	Khurmai, Ruhi Djuvanon
Kursadik	Komsomolets, Konservniy pozdniy
Konservniy pozdniy	Komsomolets, Khurmai
PLUM TREE	PLUM TREE
Satsuma	Climax, Partizanka
Climax	Partizanka, Satsuma
Vengerka ajanskaya (Greengage)	Anna Spath, Tugsod
Tugsod	Vengerka ajanskaya (Greengage), Anna Spath
Ispolinskaya	Anna Spath, Vengerka ajanskaya (Greengage)
Anna Spath	Ispolinskaya,Vengerka ajanskaya (Greengage)
CHERRY TREE	CHERRY TREE
Shpanka chernaya(Ostheim Griotte)	English early, Erfurt
Erfurt	Podbelskaya (Griotte Podbelsk), English early

Space arrangements of trees in the the orchard. The distance between the fruit trees should be determined considering soil and climate conditions and species-varietal characteristics of fruit crops. Each fruit crop, depending on the rootstock and growth vigor of the variety, should be planted in different patterns. The recommended planting schemes for fruit trees, their number per hectare and terms of tree fruiting are given in the table below:

Species	Rootstock	Space between rows, m	Space between trees in the orchard	Number of trees per ha	Fruit bearing time, years	Duration of fruiting capacity, years
Apple tree	Sievers apple seedling	7	5	333	5-6	20-25
	vegetatively propagated (clonal). Average height M-106	6-5	3-4	555-666	4-6	18-20
	Dwarf M-9	4	3	833	3-4	15-18
Pear	Tall (seedling)	6	5			30-35
	Dwarf	5-4	3-2	666-1250	4-5	25-30
Quince	Quince	6	4	416	4-5	20-25
Plum and cherry plum (lyudja)	Cherry plum	6-7	4-5	416-286	4-5	18-20
Apricot (khasaki)	Apricot	8	6	208	4-5	40-45
Peach tree	Peach	6-5	4	416-500	3-4	10-12
Pomegranate		5	4	500	3-4	30-40
Fig		5	5-4	400-500	3	20-25

Fruit crop planting order in amateur orchards. On a plot area of 600 m^2 we can accommodate up to 20-25 fruit trees, 10-15 vines, the same number of currants and 500 strawberry bushes. To better satisfy the demand for fruits and ensure their continuous supply throughout the season, varieties should be diversified. Selection of varieties should be made in accordance with the recommended standard assortment. There should be 2-3 trees of different varieties with different crop maturation times. When apples and pears are grown on dwarf rootstocks, the number of trees increased two- to five-fold with preservation of different crop time varieties.

Increasing diversity of varieties in home gardens is also useful for a better cross-pollination. It is better to plant different species of fruit crops separately. It is necessary in order to comply with measures to combat the pests and diseases of the garden, as it is often happens that the fruit ripening of one species coincides with the spraying time of another. In gardens, all major work to care for the garden is conducted manually, so with this in mind the distance between the trees should

be no less less than in industrial plantations. Thus, the most appropriate pattern for fruit tree planting is: apple trees on a vigorous rootstock 6x4; dwarf trees 4x3 m and 4x2 m; pear 6x4, 5x3 and 4x3 m; cherries and plums 6x4 and 4x3 m; apricot 6x4 and 7x5 m; peach 5x3 and 4x4 m; and cherries 6x4 and 5x4 m. When the fruit trees are planted near the borders with the neighboring site, the distance between them must equal to half the width of inter-row spacing adopted for each particular species.

Perennial pomaceous crops—apple, pear and quince—are planted in the first place in the main section. It is advisable to plant stonecrops, especially apricot, cherry and plum in a separate section along the plot borders. Sweet cherry requires good spacing between the trees. Berries can be planted between the rows of the garden or as intercrop in the rows.

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BIODIVERSITY OF THE GENUS *GOSSYPIUM* L.

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The gene pool of wild and cultivated plant species, especially their priority marketable crops, for centuries served as a genetic source for improving the economic and biological characteristics of cultivated crops. The wild relatives of cotton contribute many useful genes to the genome of their cultivated representatives, promoting higher yields, resistance to pests and diseases and improved tolerance to abiotic stress (Abdullaev *et al.* 1983, Abdullaev *et al.* 2006).

However, only at the end of the twentieth century has the international community recognized the that the study and conservation of biodiversity is important for the survival and sustainable development of mankind, as biodiversity is the basis of agricultural and economic development and an essential component of food security in every country in the world. The theoretical basis for solving the global problems of the collection, preservation, study and use of biogenetic resources was established in the early 1930s by N. I.Vavilov.

The problem of plant genetic resources conservation is closely related to the establishment and development of natural history collections, which serve as one of the most important and indispensable sources of diverse and inexhaustible information on biodiversity. Herbarium and *ex situ* and *in situ* seed collections that meet modern scientific standards are national treasuries. The major genebanks and collections of the world are in the USA, Russia, China, India, Canada, Japan, Germany, Brazil, Korea and the UK, and include the most important collections for agricultural production and food industry crops (Campbell 2010).

In Uzbekistan, one of the most valuable and important crops is cotton. The Systematics and Cotton Introduction Laboratory staff under the leadership of A. A. Abdullaev is successfully continuing work on the development of the cotton collections in Uzbekistan that were initiated by N. I. Vavilov and F. M. Mayer in the early 1930s (Central Asia Station of Vavilov's Institute, Uzbek Cotton Breeding and Seed Production Institute, Uzbek Institute of Genetics and Experimental Plant Biology). As a result of expeditions to the areas with wide species variety within the genus *Gossypium* L., and exchange of seed collections with similar organizations and centers in the world, the collection is the richest, largest and most diverse in content, not only in the Central Asian region but also in the whole world (Abdullaev

et al. 1978). This collection is registered by an International Committee (through FAO) as a gene pool rich in diversity of world's cotton. It includes several separate collections: diploid and tetraploid wild species, varieties, and lines (more than 40 representatives), about 7500 accessions of cultivated species from around the world and a variety of hybrids developed through a distant intraspecific hybridization and experimental polyploidy.

Based on the analysis results on interspecific hybridization, morphology, anatomy, cytology, geographical and environmental criteria for the genus *Gossypium* L. species, available in the collection, we have developed and proposed a new version of cotton classification (2006) (Abdullaev & Klyat 2006), based on the principle of species evolution and objective phylogenetic relationships of differently ranked taxons. Study of the natural diversity reveals ample potential of cotton wild relatives with respect to their adaptability to different environmental conditions, which, in turn, opens up inexhaustible sources for plant breeders to select the source material for breeding work to create high-quality modern varieties.

Preserving in a viable state a continuously expanding cotton gene pool is the basis for fundamental and applied research in various science fields as well as the basis for successful cotton production development in the country. The presence of the rich genetic potential and support to research on this resource contribute to the development of new priorities in the cotton industry, leading to the creation of varieties that meet the needs of the economy and are competitive in the global market.

Work on interspecific hybridization of cotton, which plays a major role in breeding efforts, has made, and is making, large and quite significant contributions to the development of the fundamental issues of cotton production industry. This is one of the most effective methods of creating new lines (Abdullaev *et al.* 1982, Rizaeva 1998).

A large group of *Houzingenia* and *Karpas* subgenera of wild diploid and tetraploid species has been studied. New data of great scientific and practical importance have been gathered.

A scheme of the phylogenetic relationship of species within and between genomes, as well as between taxonomic groups has been developed and proposed . Experiments determined that in order to efficiently use the germplasm genetic potential of the allopolyploid and diploid cotton species collection, it is necessary to consider the degree of phylogenetic relationship of parental species and their morphological and biological features (Ernazarova *et al.* 2000, Ernazarova *et al.* 2009). These data contribute to the rational selection of parental pairs for crosses and introgression of agronomic traits in the cultivar genome.

It has been demonstrated that the use of a species' close relatives and subspecies for the acceleration of the breeding process is possible and feasible. The selection scheme of source material for the development of complex hybrids with complex polygenomatic hybrids possessing a set of valuable genes has been developed. Methods and techniques for the development of various hybrids significantly increase the efficiency of recombination and provide a combination of valuable features in the new genotype.

The developed phylogenetic relationship schemes of different groups' representatives and different hybrid development methods facilitate the selection of the source material, contribute to the introgression of valuable traits, and provide effective production of new hybrid lines. For some varieties with low hybridization capacity, or even lacking this capacity, the methods of experimental polyploidy and determination of the best options have been applied at the different stages of breeding. At the same time, the efficacy of the initial receipt of intragenomic diploid hybrids, followed by a doubling of the number of chromosomes, their further hybridization with polyploids and repeated backcrossing to one of the best economically efficient lines has been proved.

A series of valuable intra-and intergenomic and three-genomic hybrids has been developed. Lines selected among the three-genomic hybrids served as the basis for breeding the Genefund-2 variety. In the process of establishing phylogenetic relationships, the genetic potential and practical value of the individual representatives was revealed. Using them as donors and applying different approaches to involve them in the selection process helped to develop and recommend a number of unique synthetic fruiting hybrids that can serve as a basis for modern variety development (Abdullaev *et al.* 2006).

Developed methods and recommendations resulting from the basic research, have led to the creation of prerequisites for successful use in practical breeding of recommended wildlife species, subspecies and lines as well as, intergenomic hybrids. Some of these species, subspecies, lines and hybids have served as the basis for local breeders to develop such varieties as Tashkent 1,, 2, 3, and 6, EA-Uzbekistan-4 AN-Bayaut-2, AN-306, AN-510, 512, 513, INEBR-1, AN-Chilyaki, Ijod, Sharaf, 75, Cornel Rawat, Kleystogam-1, promising varieties Kupaysin, AN-514, AN-516-DV (Nasaf), recently released Besh-Kakhramon and AN-16, efforts that proved to be highly cost-effective.

At present, methods of cotton germplasm collection and research, combining classical genetics with modern techniques of tissue culture, genetic engineering and molecular biology, are continuing to evolve and develop (Abdullaev *et al.* 2010).

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THE STATUS OF CULTIVARS AND WILD RELATIVES OF POMEGRANATE, (PUNICA GRANATUM L.) IN ARMENIA

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The territory of the country of Armenia is a small northeastern part of the Armenian Plateau, which is extremely interesting from the floristic point of view. N. Vavilov considered this area as one of the centers where domestication of many important cultivars occurred and where the fundamentals of horticulture were established (Vavilov 1931). In the relatively small territory of Armenia (30,000 sq. meters) grow more than 3,500 thousand species of plants, 124 of which are endemic. Many species are wild relatives and ancestors of a large number of important cultivars (Vavilov 1935, Gandilyan 1988). These include wild relatives of cereals, legumes, pulses, fodder, fruit, vegetables, oil, aromatic and medicinal plants.

The interesting fact is that the wild relatives of cultivars are largely represented not only by species, but also by intraspecific diversity, which is typical for such a valuable fruit plant relative as the pomegranate (*Punica granatum* L.) (Fig. 1).

Pomegranate is a relict plant belonging to the genus *Punica* L. Sem. Punicaceae Horan. This genus, in addition to including *P. granatum* L., also includes another – species, *P. protopunica* Balf., which is endemic to the island of Socotra in the Indian Ocean. The habitat of wild P. *granatum* covers the eastern part of the ancient Mediterranean (Anatolia) to northern Pakistan in the east. In Armenia, wild pomegranate grows in the warmest habitat in the northeast of the country; *P. granatum* grows in the wild in Ijevan and Noyemberyan areas in the

Fig. 1 Wild pomegranate from the suburbs of Megri

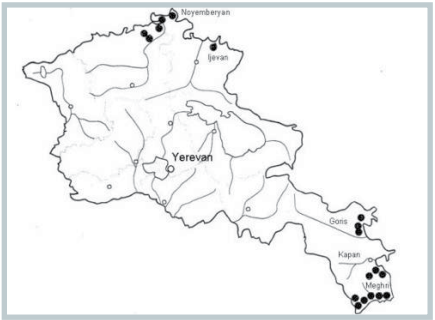

Fig. 2 Areas of wild pomegranate habitat in Armenia

southeast - in Goris, Kafan and Meghri areas (Fig. 2). In Armenia, pomegranates grow in the foothills at an altitude of 500 to 900 m, sometimes rising to 1200-1350 m above sea level.

Research on population levels revealed a large polymorphism of *P. granatum* L. in Armenia. Variations were found in habitus, leaf arrangement, leaf size and shape, type of flowers, the length of the stile, the number of sepals, size, color and shape of fruit, the degree of fruit cracking, size, color and taste of seeds, pest damage, etc. Such polymorphism, according to the botanical and geographical differential method developed by Vavilov (Gandilyan 1991), indicates aboriginality of pomegrenate in the area. Paleobotanical data testify to the indigenous nature of pomegranate in the Armenian plateau. Thus, in Sisian, Gabrielyan found pomegranate leaves in Lake Diatom sediments, which belong to the Upper Pliocene/Lower Pleistocene (Burich & Gabrielyan 2002).

The antiquity of pomegranate cultivation in Armenia is also confirmed by a large number of archaeological and ethnobotanical data. The first arheobotanical data on pomegranate dates back to the Urartu period (ninth to eleventh centuries, B.C.) and there are many images of pomegranate on the architectural monuments of the medieval period (Fig. 3). Pomegranate still holds a special place in Armenian culture and is perceived as a national symbol.

Our studies revealed a significant reduction in the area of wild habitat, and agricultural pomegranate plantations in Armenia. The causes (abiotic, biotic) that led to the reduction of the wild pomegranate area and a significant decrease in cultivation of pomegranate in the territory of Armenia have been identified. Anthropogenic factors such as cutting of trees and shrubs (pomegranate among them) for wood, arable land clearing, etc., which took place in the distant past and is still going on play a significant role in pomegranate habitat reduction .

At present, intense economic activity, land privatization and failure of irrigation systems also negatively affect and contribute to the habitat reduction.

Fig. 3 Pomegranate design on the monument in Agitu, VII c.

Measures to prevent genetic erosion and reduction of pomegranate habitat are necessary because of the considerable value of P.granatum. Pomegranate is one of the most valuable nutritional, medicinal and ornamental plant in Armenia, as well as a source of technical raw material, although this latter use is currently far from being fully exploited in Armenia. Very promising is the use of pomegranate in phytomelioration—as anti-erosion planting on slopes, shelterbelts and hedgerows, as well as for slope landscaping, which is very important for such land-poor countries as Armenia. Pomegranate is an important component of ecosystems, especially xerophilous deciduous woodlands. It is a very peculiar and ancient element of vegetation that was formed during the Tertiary period. Wild pomegranates growing in Armenia are potentially valuable donors of genes for breeding.

The analysis of botanical, geographical, paleobotanical, archaeological and ethnobotanical data testifys to Armenia's role as the location of center of origin of the cultivation of *P. granatum*. Moreover, there is currently an intensive process of formation going on. Genetic erosion, significant reduction of habitat and loss of pomegranate populations occurring today make it particularly necessary to study and protect this resource.

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WILD FRUIT CROP SPECIES DIVERSITY OF ARMENIA

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Armenia is a country of ancient horticulture that developed on the base of a rich gene pool of wild fruit trees, native flora and ancient introduced varieties.

Numerous researches has been devoted to Armenian wild fruit crop taxonomy, morphogenesis, biology, breeding and cultivation, as well as their useful properties and utilization possibilities. Based on available data it was determined that the wild fruit and nut plants in Armenia are represented by 175 species, 39 genera, and 17 families. Below is a list of wild fruit flora of Armenia. Species cultivated in the *ex-situ* collection of Flora and Vegetation Site of Armenia under the Yerevan Botanic Garden (photo 1-12) are marked with an asterisk (*).

***Anacardiaceae - Pistacia* L.** (pistachio): *P. mutica* Fisch. et C. A. Mey.*; ***Rhus* L.** (sumac): *R.coriaria* L.

***Berberidaceae - Berberis* L.** (barberry): *B. iberica* Stev.et Fisch. ex DC., *B vulgaris* L.*

***Caprifoliaceae - Lonicera* L.** (honeysuckle): *L. bracteolaris* Boiss. et Buhse, *L. caprifolium* L.*, *L. caucasica* Pall., *L. iberica* Bieb.*; ***Sambucus* L.** (elderberry): *S nigra* L., *S. tigranii* Troitzk.*; ***Viburnum* L.** (wayfaring-tree, arrow-wood, snowball): *V. lanata* L.*, *V. opulus* L.*

Pic. 1. Amelanchier ovatis *Medik.*
Foto by Akopyan J.A.

Pic. 2. Armeniaca vulgaris *Lam.*
Foto by Akopyan J.A.

Pic. 3. Cerasus *(Pall.) Spach.*
Foto by Akopyan J.A.

Pic 4. Cerasus mahaleb *(L.) Mill.*
Foto by Akopyan J.A.

Pic 5. Cornus mas *L.*
Foto by Akopyan J.A.

Pic. 6. Cydonia oblonga *Mill*.
Foto by Akopyan J.A.

Pic 7. Fragaria vesca *L.*
Foto by Akopyan J.A.

Pic 8. Pyrus sosnovskyi *Fed*.
Foto by Akopyan J.A.

***Cornaceae - Cornus* L.** (cornelian cherry): *C. mas* L.*

***Corylaceae - Corylus* L.** (hazelnut, hazel): *C. avellana* L.*, *C. colurna* L.

***Ebenaceae - Diospyros* L.** (persimmon): *D. lotus* L.

Pic 9. Pyrus tamaschjanae *Fed*.
Foto by Akopyan J.A.

Pic 10. Sorbus hajastana *Gabr*.
Foto by Akopyan J.A.

***Elaegnaceae - Elaeagnus* L.**: *E. angustifolius* L.*; ***Hippophae* L.** (sea buckthorn): *H rhamnoides* L.*

***Ericaceae - Vaccinum* L.** (bilberry, bog bilberry): *V. myrtillus* L., *V. uliginosum* L.

***Fagaceae - Castanea* Mill.** (chestnut): *C. sativa* Mill.

***Grossulariaseae - Glossularia* Mill. (**gooseberry): *G. reclinata* (L.) Mill.**; *Ribes* L. (**currant): *R. achurjanii* Mulk., *R.alpinum* L., *R. armenum* Pojark.*, *R. bibersteinii* Berl. ex DC., *R. orientale* Desf.

***Juglandaceae - Juglans* L.** (walnut): *J regia* L.*

***Moraceae - Morus* L.**(mulberry): *M. alba* L.; *M. nigra* L.(in culture); ***Ficus* L.** (fig): *F. carica* L.

Pic. 11. Vitis sylvestris *C. C. Gmel.*
Foto by Akopyan J.A.

***Punicaceae - Punica* L.** (pomegranate): *P. granatum* L.

Rhamnaceae - Rhamnus* L.** (buckthorn): *R. cathartica* L.*, *R. depressa* Grub., *R. microcarpa* Boiss., *R. pallasii* Fisch. et C. A. Mey.*, *R. spatulifolia* Fisch. et C. A. Mey.; *Ziziphus* Mill.** (jujube): *Z. jujuba* Mill.
Rosaceae - Amelanchier Medik. (June-berry): A. ovatis Medik.*; Amygdalus L. (almond): A. fenzliana (Fritsch.) Lipsky, A. nairica Fed. et Takht.; Armeniaca Mill. (apricot): A. vulgaris Lam.*; Cerasus Duhamel (cherry): C. avium (L.) Moench, C. incana (Pall.)Spach*, C. mahaleb (L.) Mill.*, C. microcarpa (C.A.Mey) Boiss., C. vulgaris Mill.; Cotoneaster Medik. (cotoneaster): C. armenus Pojark., C. integerrimus Medik.*, C. melanocarpus Fisch. ex Loudon*, C. meyeri Poyark., C. multiflorus Bunge*, C. nummularis Fisch.& C.A.Mey., C. saxatilis Pojark., C. transcaucasicus Pojark.; Crataegus L. (hawthorn): C. × armena Pojark., C. atrofusca (K. Koch) Kassumova, C. atrosanguinea Pojark., C. caucasica K. Koch, C. cinovskisii Kassumova, C. eriantha Pojark., C. gabrielianae Pojark. ex Sargsyan, C. meyeri Pojark., C. microphylla K. Koch, C. orientalis Pall., C. pallasii Griseb., C. pentagyna Waldst. et Kit.*, C. pojarkoviae Kossych, C. pontica K. Koch*, C. pseudoheterophylla Pojark., C. × razdanica Pojark. ex Sargsyan, C. rhipidophylla Gand., C. stevenii Pojark., C. susanykleinae Gabrielyan et Sargsyan, C. szovitsii Pojark., C. tournefortii Griseb., C. × ulotricha Pojark. ex Gladkova, C. × zangezura Pojark.; Cydonia Mill. (quince): C. oblonga Mill.*; Fragaria L. (strawberry): F.vesca L.*; Malus Mill. (apple-tree): M. orientalis Uglitzk.*; Mespilus L. (medlar): M. germanica L.*; Padus Mill. (bird cherry): P. racemosa (Lam.)Gilib.*; Persica Mill. (peach): P. vulgaris Mill.(cultured); Prunus Mill. (plum, blackthorn): P.divaricata Ledeb.*, P domestica L., P.spinosa L.*; Pyrus L. (pear): P.acutiserrata Gladkova, P.browiczii Mulk., P.caucasica Fed., P.chosrovica Gladkova, P.communis L., P.complexa Rubtzov, P.daralaghezii Mulk., P.demetrii Kuth., P.elata Rubtzov , P. fedorovii Kuth., P. georgica Kuth.*, P. gergerana Gladkova, P. grossheimii Fed. *P. hayastana* Fed., *P. hyrcana* Fed., *P. ketzkhovelii* Kuth., *P. medvedevii* Rubtzov*, *P. megrica* Gladkova, *P. nutans* Rubtzov, *P. oxyprion* Woronow*, *P. pseudosyriaca* Gladkova, *P. raddeana* Woronow, *P. salicifolia* Pall.*, *P. sosnovskyi* Fed.*, *P. syriaca* Boiss., *P. takhtadzhianii* Fed., *P. tamamschjanae* Fed.*, *P. taochia* Woronow, *P. theodorovii* Mulk., *P. turcomanica* Maleev, *P. voronovii* Rubtzov *P. vsevolodii* Heideman, *P. zangezura* Maleev***; Rosa* L.** (rose): *R. boissieri* Crep., *R. canina* L.*, *R. centifolia* L., *R. chinensis* Jacq., *R. corymbifera* Borkh.*, *R. damascena* Mill.*, *R. foetida* Herrm.*, *R. haemisphaerica* Herrn.*, *R. hracziana* Tamasch., *R. iberica* Stev., *R. jundzilii* Bess., *R. kazarjanii* Sosn., *R. klukii* Bess., *R. micrantha* Smith, *R. orientalis* Dupont ex Ser., *R. oxyodon* Boiss., *R. pimpinellifolia* L.*, *R. pisiformis* (Christ.) Sosn., *R. pulverulenta* M. Bieb., *R. rapinii* Boiss. et Bal., *R. sjunikii* P. Jarosch., *R. sosnovskyana* Tamamsch., *R. sosnovskyi* Chrshan., *R. teberdensis* Chrshan., *R. tschatyrdagi* Chrshan., *R. villosa* L., *R. zangezura* P. Jarosch.; ***Rubus* L.** (blackberry, rastberry): *R. armeniacus* Focke, *R. caesius* L., *R. candicans* Weihe, *R. canescens* DC., *R. cartalinicus* Juz., *R. caucasicus* Focke, *R. ibericus* Juz., *R. idaeus* L., *R. peruncinatus* (Sudre) Juz., *R. piceetorum* Juz., *R. sanctus* Schreber*, *R. saxatilis* L., *R. takhtadjanii* Mulk., *R. zangezurus* Mulk.; ***Sorbus* L.** (mountain ash): *S. armeniaca* Hedl., *S. aucuparia* L., *S. caucasica* Zinserl., *S. hajastana*

Gabr.*, *S. kuznetsvii* Zinserl.*, *S. luristanica* (Bornm.) Schonbeck-Temesy, *S. persica* Hedl., *S. roopiana* Bordz., *S. subfusca* (Ledeb.)Boiss.*, *S. takhtajanii* Gabr.*, *S. tamamschjanae* Gabr.*, *S. torminalis* (L.) Grantz

***Vitaceae - Vitis* L.** (grape): *V. sylvestris* C.C.Gmel.*, *V. vinifera* L.

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THE ROLE OF THE BIOLOGICAL CHARACTERISTICS OF CITRUS IN THE ISSUE OF THEIR SUSTAINABLE USE IN GEORGIA

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The crop gene pool of any country is its natural and historical wealth, requiring constant attention and the monitoring of current issues related to environmental changes resulting from natural and anthropogenic influences. Not only conservation of the world's constantly diminishing genetic resources but also their expansion through the intensification and rational utilization of natural and anthropogenic ecosystems are of particular importance to humanity at present. From this perspective, Georgia, which is a relatively small country, faces a difficult task, and its solution is a strategically important issue.

Citrus crops occupy a special position among all fruit plants both in terms of gross production of fruits and their volume in exports as well as the range of cultivation covering tropical and subtropical zones. These zones include a high variety of types of climate and soil conditions. Few fruit plants can compete with citrus in genetic diversity. This biodiversity serves as an inexhaustible gene pool for breeding; and the creation of new forms, sometimes radically different from existing forms of citrus. However, the success of this work requires knowledge of the physiological characteristics of individual species and even varieties. Cultivated citrus fruits belong to three genera: *Citrus, Fortunella and Poncirus*, they all belong to subgroup Citrianae (Tanaka 1989).

Hesperidium plants indisputably occupy first place in terms of usefulness, healing properties and taste among all luscious food plants. Their diversity, eternal evolutionary "youth", promising outlook and hidden possibilities of morphogenesis are amazing.

The **objects** of the research were:

a) Mandarin - *Citrus unshiu* Mar.;
b) Lemon - Novogruzinskiy;
c) Orange - Washington navel;

Each variant of the experiment covered 24 registered trees with six-fold repeatability at the fruiting-growth age period.

Unshiu mandarin (*Citrus unshiu* Mar.) significantly differs from the other species both in morphology (drooping leaves, no thorns, seedless fruits) and development ecology, which was the basis Markovich used to distinguish this species as an independent one. It is characterized by maximum winter hardiness among all cultivated citrus crops and it is the main crop in citrus production in Georgia.

Results of the study: In subtropical Georgia, along with the seasonal changes, the progress of vital plant activity is synchronized with the course of climatic conditions. In turn, these parameters affect the progress of the phenological processes of citrus plants. With respect to rainfall, the humid subtropics of Georgia are characterized by its abundance and the uneven distribution during seasons. It should be noted that the annual shoots, which are the main structural element, have several periods of growth. Our long-term experiments showed that there two waves of shoot growth at an interval of 25-35 days depending on weather conditions in the case of *Citrus unshiu* Mar. (Kacharava 1981, Gorshkov 1999). Analyzing the data of our experiments extensive fruiting of *Citrus unshiu* Mar. begins starting from 5-7 years.

It should be noted that among all fruit crops, citrus plants place the highest demands on soil fertility. Therefore, researchers use citrus as indicator plants for discovering soil supply with individual nutrients. Based on the assessment of citrus tree conditions, zones lacking macro- and micronutrients were distinguished. In Georgia, according to agronomical standards, the location of *Citrus unshiu* Mar. mandarin in plantations of 2x5 m is approved, i.e. the growing space of each plant is 10 m^2. Its most important biological feature is multi-typicality of their developing shoots and, most importantly, the great difference in the ability of individual shoots to form flowers, set fruits and maintain them until ripening. Another important feature is the nature of the species' fruiting.

Based on the biological characteristics of this crop, mandarin fruits on the shoots of the second period of growth that appeared in the preceding year and only a small portion of the yield is produced by the shoots of first growth that appeared in the current year. Annual branches can set the flower buds, regardless of their location. The formation of fruiting shoots depends on the strength and power of the tree and on the content of assimilators. Based on this, the conclusion is that the mandarin tree bears fruit every other year. Knowledge of mandarin growth and fruiting characteristics will provide an opportunity for establishing an appropriate technology model that will help cultivation of optimal and sustained citrus crop capacity.

Citrus fruit is a multilocular seeded or seedless berry with a leathery outer layer and a juicy pulp which includes segments or slices coated with a transparent shell consisting of endocarp and mesocarp. Citrus fruits include high amounts of organic acids that are easily digested by the human organism. In spite of the high acid content, the juice of citrus fruits contributes to the formation of alkaline compounds and neutralizes the extensive acidity of liquids composing the body (Kacharava 1981, Durmanov 1998). Thus acid base balance is maintained. In our experiments, the juice content of orange fruit pulp was about 91.2%; that of lemons was 94.3%; and the juice content of mandarins was 96.2% (Table No. 4).

The peel of *Citrus unshiu* Mar. contains a large amount of essential oils including limonene, citral, citronellal, and others, which gives the specific taste and smell to mandarin oil. During our experiments, 165 g of essential oil was produced from 1000 g of peel. Mandarin fruits contain 32.4 mg of vitamin C per 100 g, and 8.2% glucose, 2.25% monosaccharide and 5.94%. sucrose.

Conclusion: The study of the role of the biological characteristics of Citrus species shows that the quality and quantity of productivity that differentiates their sustainable use in Georgia, positively correlates with the mechanisms to increase the size of crown, the assimilation mechanism of trees and the number of flowers formed.

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ON THE ORIGIN OF FRUIT AND SOME INDUSTRIAL CROPS IN THE MEDITERRANEAN GENOCENTRE AND MICROGENOCENTRE OF GEORGIA

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There is a very diverse indigenous gene pool of fruit crops in Georgia which has formed and been perfected over millennia. Georgia is considered a primary or secondary genetic center of the origin of apple, pear, quince, Caucasian medlar, plums, tkemali, alycha, sweet cherry, cornelian cherry, hazelnut, etc. (Zhukovskiy 1971). The abundance of wild forms of these crops and the availability of their wild forms confirm the fact that these crops are of local origin, and derived varieties are indigenous.

Cornelian cherry (*Cornus mas *L.)

Olive (*Olea *L.)

Peach (*Persica *Mill)

This is also the thesis of N.I. Vavilov's fundamental study "The origin of cultivated plants in the world". He wrote that the origin of apple, pear, quince, tkemali, plum, sweet cherry, pomegranate, Caucasian medlar, almond, fig, chestnut and hazelnut occurred in the West Asia geobotanical center (Georgia also belongs to this center) (Vavilov 1935).

The variety of wild and cultivated forms of fruit crops in Georgia is determined by the unique soil and climatic conditions. Professor Khomizurashvili believes that, thanks to such favorable conditions, crops introduced centuries ago have become almost indigenous here (Khomizurashvili & Erstravi 1935).

A similar view is expressed by the Academician P. Zhukovsky – Georgia, as a unique endemic secondary geographic center of origin of fruit crops, has played a very specific role in the introduction of crops introduced since ancient times (Zhukovsky 1971).

As for the Mediterranean genetic center of speciation, it is very different. The ancient Mediterranean flora is spread around the Mediterranean Sea, and far to the west, up to Macronesia, and to the east throughout West Asia. The northern boundary of this flora is represented by the massive mountain ranges of the Caucasus, the Balkans, the Alps, and the Pyrenees.

The Mediterranean flora is basically ecdemic and migratory. It has formed on the vast bottom of the dried Tethys Sea. Two genetically diverse flora met here: boreal flora from the north and northeast and tropical, mostly African, from the south. The evidence of the juxtaposition and mixing of these tow floras are seen in many species of the Mediterranean flora (Khrzhanovsky *et al.* 1986).

Some authors refer the Colchis area of Georgia to the Mediterranean region since the vegetation of this province in its present state and in the process of its development are inseparably linked to that of the Mediterranean region. Thus Colchis is considered one of the subprovinces of the Evksin province that belongs to the Mediterranean region. This explains why the floras of the Mediterranean basin and West Asia, specifically Georgia, have much in common.

As a result of long-term field work, six independent microfoci of seed crops origin have been identified: Ajara-Gurian, Kolkheti, Racha-Lechkhumi, Imereti, Meskheti, Kartli and Kakheti. Originating from these areas are 125 indigenous forms and varieties of apple, 102 of pear, 65 of quince and 10 of Caucasian medlar (Akhvlediani 1979).

Georgian varieties of apple and pear were first thoroughly studied by Professor N. Khomizurashvili and E. Eristavi (Khomizurashvili & Eristravi 1935). They found that *M. Orientalis uglitz* – the Mazhalo species—is the predecessor of wild apple in Georgia. *M.Silvestris Mill* and *M. pumila* participated in the formation of apple varieties in the Mediterranean basin. The latter took part in the origin of the Georgian collection of apple varieties. Professor Khomizurashvili subdivides local apple varieties into the following groups: 1. Dzudzu vashli, 2. Tip kitra vashli, 3. Turashauli and 4. Abilauri. He also includes in the above-mentioned groups of varieties those which, in spite of the fact that they originated from *M.Orientalis,* significantly differ from them, for example, Kekhura in Kartli and Rkina vashli in Adjara, and the Lagodekhi rennet variety was also absolutely different (Khomizurashvili & Eristravi 1935).

P. Caucasica Av Fed – Panta is the predecessor of Georgian pear varieties. Panta and Mazhalo are widespread in forests both in valleys and mountains above an altitude of 1500-1700 m above sea level. Local pear varieties are grouped according to pomolological traits: 1. Gulabebi, 2. Panta mskhlebi, 3. Kalos mskhlebi, 4. Khechechurebi. The above-mentioned groups, except for Gulabebi, were obtained from *P. Caucasica* species through breeding and cultivation (Khomizurashvili & Erstravi 1935).

The following species participated in formation of the collection of pear varieties in the Mediterranean countries: *P. Amygdaliformis Vilars* (found in Spain, Italy, Greece, and southern France), a related group, *P. nivalis Jasg* (spread throughout Europe) and *P. communis L., a* wild forest group (found in Central Europe).

Common Georgian stone crops belong to the families of Rosacea, cornelian cherry and oleaster. The rose family is represented by *Prunus Mill*, *Persica Mill*, *Armeniaca Mill* and *Cerasus Juss* genera. The Cornelian cherry family is represented by *Cornus L*. genus and the oleaster family by the *Elaeagnus* genus.

The plum genus – *Prunus Mill* – has 30 species. Georgia is the center of origin for five of them: *P. domestica L*, *P. cerasifera Ehrh*, *P. vachuschtii Breg*, *P. institia L*. and *P. spinosa L*.

Peach – *Persica Mill*—is represented by a single species, *P. vulgaris Mill,* in Georgia. This is a cultivated crop. Its wild forms have not been found. This species has long been cultivated in Georgia, which is confirmed by the existence of many varieties and varietal forms that are specific to Georgia and that greatly differ from the varieties common in other parts of their distribution.

Only one species of the **apricot** genus, *Armeniaca Mill, A. vulgaris,* is found in Georgia. Two subspecies are widespread here. One is Zherdel – a local wild form, which has small fruits with a bitter stone and a rough peel. The second is represented by large apricots with sweet fruit and an edible stone. The kernel of the stone is also sweet too. Batonishvili mentions "Kaisi" when describing the fruits that have a smooth, glossy peel (Batonishvili 1978).

Sweet cherry and the cherry genus *Cerasus* include 150 species. Georgia is homeland to sweet cherry (*Cerasus avium L*.), common cherry (*C. vulgaris Mill)* and Nanking cherry (*C. mahaleb L)*. Common cherry is a cultivated species which is not known in the wild. Georgian sweet cherry varieties originate from Balamtsara (wild cherry). Nanking cherry is found only in the wild. It is used as seedling stock for cherry and sweet cherry trees in agriculture.

Georgia is one of the centers of origin of cornelian cherry (*Cornus mas L*.). Cornelian cherry is found in the wild in the forests of eastern Georgia. On household plots large-fruited forms are found that were obtained through breeding.

Oleaster: – *Elaeagnus angustifolia L*. is found in groves in the wild. Its wild forms are small-fruited but they also include large-fruited forms which provided the basis for cultivated forms.

According to the data of universally recognized centers of **walnut** origin (*Juglans L*) in the Transcaucasia, particularly in Georgia, this country is not considered a center of origin of this crop. However, studies carried out by

Georgian scientists prove the contrary. Based on the analysis of walnut farina, Gogichayshvili concludes that about 18-20 thousand years ago walnut forests grew along the river Iori in the current Sagaredzho District, which gives reason to consider Georgia one of the centers of origin of walnut (Gogichaishvili 1962). Ketskhoveli came to a similar conclusion: "In the past, most of the territory of Georgia was covered with walnut trees, which were subsequently destroyed by improper (predatory) use" (Ketskhoveli 1957).

There is much archeological evidence for the existence of **hazelnut** (*Corilus L*.) in Georgia and the tradition of its use, among which materials found near Nosiri village and on Dikha Gudzubo settlement of the Eneolithic period are worth mentioning. Well-preserved remains of hazelnuts and other plant crops, as well as various stone tools including hand mills, were found here (Khoshtaria 1944). Georgia as the center of origin of hazelnut crop is also confirmed by the fact that of the world's 22 hazelnut species, seven of them grow in the wild here. Of these, four species: common hazelnut – *C. avellana L*.; Pontic nut – *C. pontica or C*. *Kochi*; Turkish hazelnut – *C. colurna L*.; and Georgian hazelnut – *C.iberica Wittman. et kemular*, are found in other regions of the Caucasus, in Asia Minor and in Europe, as well as in Georgia. The three remaining species (Colchis hazelnut - *C. colchica* All, Imereti hazelnut *C. imeretica* Kemullar nat. and Kakheti hazelnut *C. kachetika)* are endemic to Georgia. Another species, the eighth one, is *C. maxima,* which is found only as cultivated crop. Hazelnut varieties derived from the common and Pontine species are also widely distributed in agriculture (Gotsiridze 1979).

The the only universally recognized center of origin of **laurel** (*Laurus nobilis* L.) and **olive** (*Olea* L.) is the Mediterranean. However, studies have confirmed that these crops also independently originated in Georgia.

Grosheim notes the role of the Mediterranean flora in Colchis. He points out that in southern areas of Colchis small fragments of maquis and separate elements of the Mediterranean flora such as laurel, strawberry tree, etc. are found (Grosgeim 1936). Svanadze believes that laurel, as well as strawberry tree and many other Mediterranean crops, although originating in the Mediterranean zone, grew in the territory of West Georgia over whole geological periods, numbering several hundred thousand years. Therefore, Colchis can be considered the birthplace of laurel along with the Mediterranean (Svanadze 1951). The oldest natural laurel thickets are located on Urta mountain, where more than 2000 hectares were covered with laurel groves, or rather small copses where laurel and olive trees grew together with other shrubs, rarely buckthorn, under oaks and hazelnut and even more rarely under the canopy of beech, hornbeam, etc. (Svanadze 1951).

Another crop common to the Mediterranean flora is olive (*Olea* L.). In Georgia, only its cultivated form is widespread – *O. europeae* L. There is information that it was cultivated in Georgia even in prehistoric times. In Colchis on Urta mountain in maquis-type phytocenosis, olive is found along with laurel. According to Shavrov's description, there were 800-1000-year-old olive trees in Tao-Klardzheti (now territory of Turkey) (Shavrov 1912).

Based on the evidence discussed above, it can be concluded that the flora of the Mediterranean has many connections to Georgia. For this reason, we consider it expedient to enhance ties for collaborative research.

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RECOVERY AND SUSTAINABLE USE OF GEORGIA'S FRUIT BIODIVERSITY

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Introduction

Georgia, with its 30-century history, lies on the southeastern boundary of Europe, between the Greater and Lesser Caucasus and the Black Sea, an area defined by Conservation International as one of the world's biological hotspots. Georgia has 22 soil-climatic zones in only 69,700 km2 and possesses unique plant diversity. Its agriculture can be traced back seven or eight thousand years, when Georgian tribes began to domesticate basic crops such as wheat, barley, oat, rye, legumes and fruit species. Not long ago, widely cultivated crops included millet, rye, endemic wheat varieties, chickpea, lentil, beans and pea vine, as well as plants grown for their oil and fiber content. Georgia has a rich flora, both in terms of wild species (more than 4,200) and crop species (about 100 families and 350 local species of grain crops), as well as more than 100 species of seed and stone fruit-trees, nuts and wild berries. More than 500 local varieties of grapes have been recorded, although only 300 are grown today (Agladze & Korakhashvili 1999).

Today many of these crops are absent or under-represented in the local farming systems. Agricultural practices over the last 90 years have resulted in significant erosion of agro-biodiversity, which has undermined crop production sustainability. In Soviet times most family plots and collective farms grew introduced varieties and local landraces were generally only cultivated by agricultural research centers. When state funding ceased, the process of agro-biodiversity loss intensified as valuable collections and stocks of landraces began to deteriorate. At the same time, farmers found themselves stuck with introduced varieties that needed quantities of agrochemicals and water that they could neither provide nor purchase. Although local varieties would have performed much better, they were not available for planting and the research centers lacked the capacity to assist farmers in reintroducing them (Buddenhagen 1983).

Fruit adds diversity to diets and is a major source of the vitamins and antioxidants necessary for healthy human populations. Research includes the study of nutritionally-related components in diverse fruit types, and the examination of the variation in life cycle timing (for example, bud break) required to adapt fruit crops to future and current climates (Frankel & Soule 1981).

Objectives and Methods

A special project was carried out by the Georgian Agrarian University (GAU) in order to remove the institutional, knowledge and market barriers that hamper the conservation and sustainable use of fruit agro-biodiversity. The project interventions included the establishment of fruit sources of primary seed/ seedlings and other planting material for the threatened fruit varieties and the strengthening of local pilot plots.

GAU collects fruit germplasm, improves it, and distributes seed and planting material, helping farmers access markets, including specialist markets for organic products. The university works to facilitate experience-sharing among farmers and to enhance information access by farmers, authorities, research stations, donors and other stakeholders. GAU has established a fruit seedling multiplication program to encourage local farmers to pursue agro-biodiversity objectives. Planting material stored in GAU has been multiplied on the university's demonstration plot and distributed to farmers. A fruit nursery has also been established at the demonstration plot and planting material for further multiplication has been collected in various regions of Georgia.

GAU is the main institution directly involved in *ex-situ*/on farm conservation activities for fruit varieties. It serves as the main provider for the production and distribution of seedlings and planting material and facilitates local level experience-sharing. GAU has created a seedlings bank and all institutions have agreed to join the seed and seedlings multiplication system of fruit seeds and seedlings distributed to farmers for their own conservation system. Georgian Agrarian University research centers are also receiving training and extension services on a regular basis (Cubero & Moreno 1999).

Results and Analyses

From the above mentioned it is clear that the GAU is playing important role in the collection and improvement of cultivated and wild fruit germplazm and its spread throughout the world. It is the region of unique diversity. But today this diversity is on the brink of disappearing. At present the number of fruit germplasm populations, especially of varieties, is catastrophically decreased. Such a fate will befall many other cultivars as the progress of scientific selection becomes more active in future, to be followed by decreases in plant diversity. We consider that, together with these processes, the protection and maintenance of fruit genetic resources, especially in those countries which belong to centers of origin of fruit cultivation, should be intensified. Georgia is one such country. The main fruit species of Georgia are:

- **Pear** (*Prunus*). The following pear species are growing in Georgia: *P. salicifolia*; Georgian pear, *P. sachokiana* Kuth (central Georgia – Shida Kartli, wild); sakhokia pear, *P. sachakiana* Kuth (Shida Kartli – central Georgia, wild); *P. taochia* Woron. (Achara, wild); *P. fedorovii* Kuth (central Georgia, wild); *P. demetrii* Kuth (central Georgia, wild); *P. ketZkhovelii* Kuth (central Georgia, wild); *P. eldarica* Grossh. Zhukovski thinks that the Caucasus represents the main area of wild and cultivated pear (Dzhukovski 1964).

- **Apple** (*Malus*): Apple growing in the wild is represented mainly by one species – *M. orientalis* Uglitzk. This species participated in the formation of endemic cultivated varieties. The local varieties are Georgia Sinapi and Kekhura.
- **Quince** (*Cydonia* Mill.): In Georgia there is evidence of the cultivation of *Sorbus* L. since ancient times. Central Asia is one of the centers of origin of these cultivars. In Georgia proper *S. colchica* Zinserh has been described.
- **Peach**: There are six local varieties in Georgia: Khedistauri white, Georgian peach, Wazhuri, Berebis peach, Bestavashvili late, Childistauri yellow
- **Ficus**: This species is widespread in Georgia, especially in west Georgia. *F. colchica* Crossh. is endemic to Kolkheti.
- **Corylus**: Central Asia is the secondary centre of this fruit. Speceis *C. colchica* Albov is present in Georgia, widespread in west Georgia and Apkhazeti.
- **Chestnut** (*Castanea* Mill.): *C. sativa* is a wild species in west Georgia.
- **Vine grape** (*Vitis* L.): The ancestor of the cultivar vine *Vitis siluestris* Gmel. is widespread in Georgia; there are 400 local species of vine in Georgia (Dzhukovski 1964).

The GAU special project promotes the conservation and sustainable use of the threatened local fruit genetic resources that are important for food production and safety. It supports the development and implementation of a strategy to replicate best practices in the conservation and use of local fruit biodiversity in other regions of Georgia.

The project focused on the following major activities:

1. establishment of sources of primary fruit planting material for the threatened crops and fruit varieties, oriented toward local consumption and export;
2. collection of wild fruit germplasm in forests and old settlements;
3. supporting the local farmers in the implementation of Global Plan of Action for Plant Genetic Resources for Food and Agriculture;
4. assistance to farmers in accessing export markets;
5. dissemination of information on local agricultural biodiversity among the farmers, authorities, research stations, donors and other stakeholders;
6. replication of the best agricultural practices in all regions of the country;
7. extending a hand to farmers producing grafting materials and new varieties of fruits.

Georgia owes its high diversity of plant species to a number of factors: its location as a geographical gateway between the continents of Asia and Europe, the existence of 16 different climatic types in a relatively small area, the low level of glaciation during the Pleistocene era, and the very high habitat diversity. Therefore the country is an important reservoir of crop genetic diversity for cereals, vegetables and fruit. This agricultural biodiversity expanded over thousands of years, with the contribution of many different cultures. Today, however, this diversity is rapidly being eroded by government agricultural policies, climate change, globalization, population increase and other socio-economic causes. Diminishing agricultural biodiversity puts the food supplies of future generations

at risk and undermines cultural diversity, so that it is clear that "agro biodiversity is the key of sustainable development" (Korakhashvili 2001).

Although the Fruit Heritage Project at GAU began only recently and is a pilot project confined to one of Georgia's 51 districts, it has made rapid headway and attracted considerable interest. Our members have presented papers at several meetings and conferences (the most recent was in 2010) and the response at these events has been enthusiastic and encouraging. We have also received many offers of help, which has raised our hopes that the project will be able to expand throughout the country with the support of volunteers. In particular, the enthusiastic response of local people to our endeavors to preserve the traditional varieties planted and developed by their ancestors has convinced us that the project has the potential to become a strong grassroots movement. The interest we show reaffirms the value of these traditional fruit crops in their own eyes, and they are as delighted as we are when yet another variety is discovered and added to our database. In addition to these efforts by local people to conserve local varieties in their own orchards, the involvement of local authorities is vital. During the next four years we plan to bring together representatives of local municipalities and government agricultural offices with producers to discuss the issue and seek practical solutions. We believe that a solution that does not involve local people cannot succeed in the long run.

Our project's sustainability also undoubtedly depends on developing marketing opportunities for at least some heritage fruits. One possible method may be 'added value' by such means as packaging and processing. Not every traditional variety has economic potential in our modern world, but some varieties are equally valuable in terms of agricultural biodiversity—some fruit early, some are good for making molasses, some keep well. Above all, they are ecologically friendly, requiring little or no water, modern (specific for fruits) fertilizer and pesticides. This means that they are also healthier, both for us and the environment, producing safe products under the Global Plan of Action. Policy also requires that we focus on maintaining sustainable food production and rural communities, and on developing crops and cropping practices which reduce harmful effects on the environment. The exploration and utilization of crop biodiversity is helping us to meet all of these aims.

Adaptation to current and future climate change is an essential part of preparing for a sustainable future. We need to prioritize the traits for improvement and identify the genes and combinations of genes which underpin these traits. Only then can we use knowledge-based crop improvement to its full potential in managing the effects of climate change.

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APPLICATION OF DNA MARKERS TO ASSESS GENETIC DIVERSITY OF *PYRUS CAUCASICA* L. POPULATIONS IN ARMENIA

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Introduction

Armenia, as one of the world's centers for agro-biodiversity, has a relatively large area sustaining crop wild relatives (CWRs) and agricultural varieties (Khanjyan 2004, Zhukovsky 1971). It is considered to be a part of the centre of origin for many cultivars, including pears. In Armenia 32 species of the genus *Pyrus* L. grow, of which 12 species are endemic. This data indicates an intensive speciation processes in the genus *Pyrus* in Armenia, particularly in the southern regions of country. Wild pear (*Pyrus caucasica*) occurs in mixed hardwood forests, in hedges on farmland and can be used in crop improvement programs as a source of cold and drought-resistance and for genotypes that are, undemanding with regard to soil conditions. They are very important for forestation and production of timber wood and are highly valued on the market. Fruits of wild pears are widely used by native populations.

The value of wild species as a genetic resource for crop improvement depends on the amount of genetic variability they represent relative to cultivated crops. A large number of methods are available for the assessment of the genetic variability, diversity and relatedness among cultivars as well as for molecular fingerprinting. Several PCR-based systems are available that differ in complexity, reliability and information-generating capacity. These include RAPD (random amplified polymorphic DNA), SSR (Simple Sequence Repeat) and AFLP (amplified fragment length polymorphism), among others. Each system has its advantages and disadvantages. The introduction of RAPD (Stift *et al.* 2003) or AP-PCR (Arbitrarily primed polymerase chain reaction) allowed DNA analysis using the polymerase chain reaction (PCR) in the absence of specific information on nucleotide sequences. It proved valuable in the characterization and evaluation of genetic diversity within and among species and populations. The purpose of the present study was to assess, through the use of RAPD markers, the genetic diversity in wild populations of *Pyrus caucasic*a growing in Armenia.

Materials and Methods

Plant material: Randomly collected from different sites of Armenia, eleven populations of *Pyrus caucasica* were chosen for RAPD marker analyses.

DNA isolation: DNA from young leafs and seedling of *P. caucasica* was extracted by application Cetyl trimethylammonium bromide (CTAB) modified protocol (Williams *et al.* 1990).

PCR amplification and gel electrophoresis: For RAPD analyses 15 10-mer primers were used: OPA01, OPA02, OPA03, OPA04, OPA05, OPA 07, OPA 08, OPA 09, OPA11, OPA 12, OPA 13, OPA 18, OPA 20, OPE03 and OPE04 (Doyle 1990). PCR amplification was conduced according the following PCR profile: 94 ^{0}C – 1.5 min, 40 cycles (94 ^{0}C–30 sec., 36 ^{0}C–1 min, 72 ^{0}C–1 min), 72^{0}C –10 min. PCR amplified RAPD DNA fragments were electrophoresed in 2% agarose gels at 110 V for about 2 hours, stained with ethidium bromide, visualized under UV light and photographed. To analyse the molecular genetic data, Popgene 32 software was used. Data were analysed on the basis of the presence (1) or absence (0) of the amplified products. Pair-wise comparisons of accessions based on presence/absence of unique and shared polymorphic products were used to generate the observed number of alleles, effective number of allele, and percentage of polymorphic alleles.

Results and Discussion

Many reports indicated that RAPD analysis can discriminate pear genotypes and suggest this technique as a reliable, inexpensive method and an important tool for the study of genetic diversity and genetic resource management of pears (Oliveira *et al.* 1999, Sawazaki *et al.* 2002, Schiliro *et al.* 2001). The 15 primers amplified 211 DNA fragments, including 53 non-polymorphic fragments. Thus, 124 fragments were polymorphic (58.8%) in one or the other of the seven genotypes. There was not a single primer (out of the 15 studied) which could differentiate clearly between all the populations (Fig. 1).

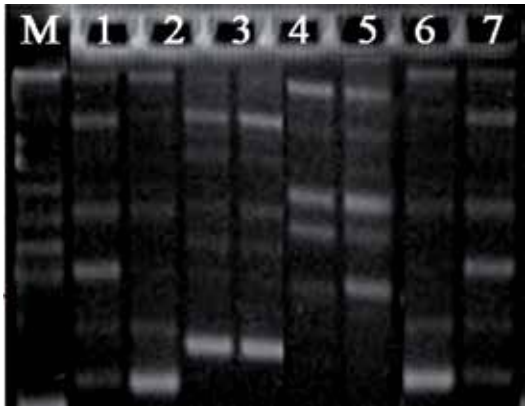

Fig.1 RAPD patterns of genotypes within the *Pyrus caucasica* (lines 2-7) obtained with primer OPA09. M: DNA size markers (DNA ladder, Fermentas, 100 bp).

The different primers revealed different levels of polymorphisms among the five pear genotypes. The highest number of amplified DNA fragments was 14 with OPA09, while the lowest number was four with the primer OPA11. The number of polymorphic amplicons per primer ranged from two (primer OPA03) to 14 (primer OPA09). The average number of amplified fragments per primer across the five genotypes was 5.68 and the average number of polymorphic amplified fragments was 8.48.

The distribution of genetic diversity allows the design of rational sampling strategies to capture the genotypic range. There is a concern expressed in the literature regarding the reproducibility of RAPD patterns from one experiment to another. In this study reproducibility of these results was evaluated by replicating the RAPD analysis done on all the accessions two to three times with fifteen primers. Reproducibility averaged 94%. Thus under stringent reaction conditions RAPD patterns were highly reproducible. These results demonstrated that RAPD-PCR analysis is useful for assessing the extent of genetic diversity among *Pyrus* accessions and can provide practical information for the management of genetic resource collection and identification.

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USE OF GEOGRAPHIC INFORMATION SYSTEMS TO LINK SOCIO-ECONOMIC PARAMETERS WITH UNDERUTILIZED FRUIT GENETIC DIVERSITY FOR LIVELIHOOD DEVELOPMENT

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Introduction

Fruits play an important role in the day-to-day-life of people owing to their unique flavors and nutritional and medicinal values. As a result of the country's wide range of ecosystem diversity and climatic conditions, the diversity of fruit crops is high in Sri Lanka. There are, for example, over 237 fruit species from 56 plant families available on the island (Pushpakumara & Silva 2009). Though the diversity is high, at present only a very few fruit species are commercially cultivated. Nearly 90% of these fruit crops are grown in home gardens and are managed by rural communities. A vast majority of fruit species available in Sri Lanka are grown naturally, but are seldom exploited even as fresh fruits. These are generally known as "*neglected and underutilized fruits*" (NUF). With a proper identification of the places where they grow, and with further research and development and promotional programmes on the most important varieties, they can be used extensively to improve household food and nutritional security and income generation potential with enhanced environmental services. However, to date, the information pertaining to the eco-geographical distribution of underutilized fruit species is scarce. To shed light on the issue, the specific objective of this study was to map the probability locations of NUF species in Sri Lanka, and in turn, to identify the priority NUF crops to be used for livelihood improvement.

Methodology

The study was designed to be completed in two phases: (1) *Phase I* to understand the current status of NUF species in Sri Lanka and use that knowledge to develop maps illustrating their present locations, and (2) *Phase II* to select the most priority NUF species amongst the NUF identified in Phase I. The steps used to achieve these tasks are briefly described:

Phase I – Identification of NUF and Development of Probability Maps

A systematic and comprehensive review of literature and various sources of secondary data was carried out to understand the current status of NUF, followed by a random field inspection process for further verification of the information. At the end of this process, 30 NUF species were identified for further investigation (e.g. Wood apple, Beli, Anona, Tamarind), distributed in 3219 tree locations representing all the administrative districts in Sri Lanka. Next, the Global Positioning System (GPS) under Kandawala Geographic Coordinate System in decimal degrees (WGS 84) was utilized to record this information methodically. Once the information was in order, we used the: (a) FloraMap (CIAT), and (b) DIVA-GIS 5.2 software versions for the purpose of probability mapping of NUF species through the principle component analysis and ecological niche modeling approaches, respectively.

Phase II - Development of priority fruit selection criteria

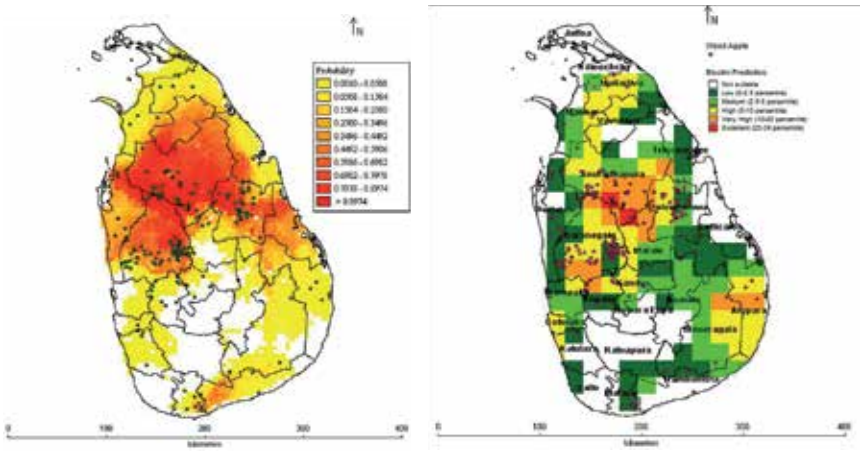
To begin with the analysis on which the selection of priority fruits (amongst the 30 selected in Phase I) was based, the criteria developed by Williams and Haq (2002) to "select priority crops for a given geographical region or a nation" was employed (Williams, J. T. and Haq 2002). However, we have resolved to add another two statements to the original set of 21 statements developed for this purpose to adequately reflect the facts and figures found through review of literature and expertise knowledge. Scores were provided by the panel of experts for each of the 23 statements on a 3-point likert-scale [i.e. "High (3)", "Moderate (2)" and "Low (1)"] to determine the relative importance of phenomena explained in each statement to select a priority NUF species. These were then used to derive an additive index, termed the *Fruit Selection Index* (FSI), as follows:

$$\sum_{s=1}^{m} \quad FSI_i = a_{is} \cdot U_s / aU$$

where: a_{is} = score given to a statement (U_s) for the fruit *i*; U_s = number of statements per category, and *aU* = Maximum Potential Score (see, Jayasinghe-Mudalige and Henson, 2006). The value of FSI obtained by means of Component Factor Analysis (CFA) range from "0" to "1", i.e. a NUF species with the highest positive value is the best fruit to be selected.

Results and Discussion

Sixty maps were produced using the FloraMap and DIVA-GIS software. Each illustrates the probability distributions of NUF species in different geographical regions in Sri Lanka. Figure 1 below, for example, shows the maps produced for wood apple using GIS software.



Flora Map ***DIVA-GIS***

Figure 1. Probability map drawn for Wood Apple using GIS software

The outcome of analysis based on FSI suggests that amongst the 30 NUF species considered in the study, wood apple (*Limonia acidissima* L) possesses the highest value of 0.698.

Conclusions

The results suggest that wood apple is the most suitable NUF crop to be promoted out of 30 considered in the analysis. Given the facts that it is grown in areas where food and nutrition insecurity is relatively high; it has an ability to cope up with any adverse affects of climate changes and to produce fruits in large quantities, and it can be handled with minimum post-harvest losses, awareness and training, wood apple can be promoted for commercial cultivation with minimum effort (Jayasinghe-Mudalige & Henson 2006).

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SPECIES DIVERSITY OF *PYRUS* GENUS AND ITS USE IN THE BREEDING OF ADAPTED VARIETIES

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Adaptive breeding in Russia is the main tool used in the development of new varieties of fruit crops. In this regard, the use of parental forms adapted to local environments, wild species, old varieties from traditional breeding and modern varieties with a wide range of reaction are important sources for practical breeding.

The *Pyrus* genus includes a large number of species: *P. syriaca* Broiss*., P. korshinskyi* Pall*., P. regelii* Rehd., *P. salicifolia* Pall., *P. amygdaliformis* Vill., *P. eleagnifolia* Pall., *P. nivalis* Jaeg., *P. pyraster* Burgsd., *P. caucasica* Fed., *P. turcomanica* Maleev., *P. ussuriensis.* Maxim., *P. pyrifolia* (Burm.) Nakai., *P. bretschneideri* Rehd., *P. serrulata* Rehd., *P. pashia* Hamilt., *P. betulifolia* Bunge., *P. calleriana* Decne. and *P. phaeocarpa* Rehd. In Asia, the modern assortment of pears mainly consists of *P. pyrifolia*, *P. bretschneideri, P. ussuriensis,* and *P. pashia*. The characteristic feature of the Asian pear is the juicy spalling flesh of its fruit.

In Europe, North America, Australia and New Zealand the main grown varieties are *P. communis*. In the wild, the pear tree grows in the ordinary forest-steppe zone of European Russia, in the mountain forests of Central Asia, South and Central Europe and in Asia Minor. Varieties obtained from this wild pear are traditional European ones known for their buttery, juicy flesh. Undoubtedly, different varieties have taken part in the formation of modern European pear varieties, but a special role, particularly for the northern horticultural areas, belongs to *P. ussuriensis*.

Ussurian pear's habitat covers a vast area of the East, Russia, Korea and northeastern China. The main work involving Ussurian pear in practical breeding in Russia belongs to I. Michurin, who carried out interspecific hybridization of this species, due to its high frost resistance, with local and European varieties and developed well-known varieties with high winter-hardiness, in particular, the famous Bere variety.

In the State Research Enterprise "All-Russia Breeding Technology Institute of Horticulture and Nursery Keeping" of the Russian Academy of Agricultural Sciences, pear breeding was started in 1932, by V.A. Efimov, while later breeding work was continued by A.V. Petrov, Ya.A. Petrov, and in 1968, variety study and joint selection of elites was continued by N.V. Efimova. In the early stages of breeding work, inter-varietal crosses on the basis of the Central Russian and

Western European varieties was conducted. This practice resulted in a hybrid with fruits of good quality but low winter-hardiness. The next stage of pear selection was conducted in two directions;

1. crossing varieties of national selection with the Southern and Western European ones;
2. crossing the Ussurian pear varieties with Western ones.

The offspring obtained from the Ussurian pear had the dominate traits of high adaptability (winter hardiness, resistance to fungal diseases) and low-marketability fruit quality. Further skillful use of selected genotypes with high economically valuable traits led to lines with good fruit quality and sufficient for the central non-black soil zone level of adaptability in the F3 and F4 from *P. ussuriensis*.

Modern varieties with good adaptability and an optimum combination of productivity components had been developed on the basis of a large hybrid gene pool. The work that started in the 1930s began only in 2000 to take the right direction, with the first Moscow pear varieties submitted to the State Variety Trial Commission: Velesa, Petrovskaya, Vidnaya, Vernaya,Yuryevskaya, Detskaya and Dyuymovocka. Further analysis and hybrid gene pool variety study selected two more varieties out of the elite lines: Rovesnitsa and Bananovaya.

Velesa (Venera x Lesnaya Krasavitsa): Developed by Yu.A. Petrov, N.V. Efimova. The tree is winter-hardy, average height, early fruit bearing (starts to bear fruit after 4 to 5 years). Yielding capacity is 29-32 t/ha. Fruit of the autumn crop have has good palatability (until mid-November): greenish-yellow, large (150±25 g), juicy flesh with good sweet-sour taste (4.6 points). Scab resistance is higher than average.

Petrovskaya (interspecific hybrid 2-22-60 x Sentyabrskaya): Developed by Yu.A. Petrov, N.V. Efimova. The tree is winter-hardy, of average height, early fruiting (starts to bear fruit at 3 to 4 years). Yielding capacity is 28-30 t/ha. Fruit ripen and are consumed in summer, high palatability: greenish-yellow, medium size (130±20 g) with juicy flesh, good sweet-sour taste (4.6 points). The variety is scab resistant.

Vidnaya (interspecific hybrid of VI-53-67 x pollen mixture of southern varieties): Developed by Y.A. Petrov, N.V. Efimova. The tree is winter-hardy, tall, early fruit bearing (starts to bear fruit at 3-4 year). Yielding capacity is 24 t/ha. Fruit ripen and consumed in summer (end of August), have high palatability: greenish-yellow, of the medium size (155±15 g) with very juicy sour-sweet flesh, good taste (4, 4). It is resistant to scab.

Vernaya (interspecific hybrid of # 9 x Josephina mehelnskaya). The tree is winter-hardy, medium height, early fruit bearing (starts to bear fruit at 4-5 years). Yielding capacity is 24 t/ha. Fruit ripen and are consumed in late autumn (till December), and have good marketable traits. Greenish-yellow, of the medium size (120±20 g) with very juicy sour-sweet flesh, good taste (4,4). It is resistant to scab.

Yuryevskaya (interspecific hybrid # 9 of open pollination). The tree is winter-hardy, tall, with drooping crown of medium density, early fruit bearing (starts to bear fruit at 2-3 years). Yielding capacity is 25-30 t/ha. Fruit ripen in late season,

and are greenish-yellow, of medium size (110±20 g) with very juicy sour-sweet flesh, good taste (4,4). It is resistant to scab.

Detskaya (elite line #8 x summer Duchess). The tree is winter-hardy, tall, early fruit bearing (starts to bear fruit at 4 years). Yielding capacity is 15-20 t/ha. Fruit ripen and are consumed in early season (end of July), yellow color, not large (60±40 g) with very sweet juicy flesh, good taste (4,6). Its resistance to scab is medium.

Dyuymovocka (interspecific hybrid # 9 x pollen mixture of southern varieties). The tree is winter-hardy, of medium height, with rounded crown, mid-season maturing, early fruit bearing (starts to bear fruit at 6-7 years). Yielding capacity is 15-17 t/ha. Fruit are consumed in autumn, until December, with yellow-brown skin, high palatability, not large (70±15 g) with juicy flesh, sweet taste (4,7). The variety is resistant to scab.

Rovesnitsa (Tonkovetka x Cure): Developed by V.A. Efimov, Yu.A. Petrov, N.V. Efimova, V.S. Girichev. The tree is winter-hardy, natural semi-dwarf, early-fruiting (starts to bear fruit at 3-4 years). Yielding capacity is 25-30 t/ha. The fruit are consumed in autumn (until mid-November), picked when green with further after-ripening, fruit are of high palatability, greenish-yellow skin with some red blush, of the medium size (120±15 g) with juicy flesh, sour-sweet taste (4,5 points). The variety is scab resistant.

Bananovaya (Naryadnaya Efimova of free pollination): Developed by Yu.A. Petrov, N.V. Efimova, V.S. Girichev. The tree is winter-hardy, of medium height, natural semi-dwarf, early-fruiting (starts to bear fruit at 3-4 years). Yielding capacity is 25-30 t/ha. Fruit ripen in summer and are consumed until the mid of October. Fruit have crunchy juicy flesh when picked from the tree, after further storage acquiring a juicy buttery mellowness and high palatability. The fruit is greenish with brown-red blush, medium size- 135±15 g, good sweet taste (4.6 points). The variety is scab resistant.

Under modern market economy conditions, demand for the newly developed varieties of fruit crops have increased. The priority traits for new varieties nowadays are productivity and fruit quality, disease resistance, habitus and, for the northern regions of cultivation, winter - hardiness. A combination of as many valuable traits as possible in one genotype is possible with continuous breeding work.

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THE ROLE OF OLD VARIETIES OF WHEAT IN BIOFORTIFICATION OF FLOUR

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Humanity has been occupied with the breeding of wheat for many centuries. Annually 620,000,000 tons of grains are produced all over the world. However, its nutritional value has not risen at all for a long period of time, but has even been reduced (Waters *et al.* 2009). Turning to the wild roots of wheat, researchers have identified the gene which is able to increase the nutritional value by reducing the date of ripening.

One of the staff of an international team of researchers, Jorge Dubcovsky, a breeder at the University of California in Davis identified the gene (called gpc-B1), which influences the protein content in the Emmer wheat variety (two-grained wheat or *Triticum dicoccum*) and has grown in the Middle East for many centuries. He could cultivate and study wheat varieties and identified non-functional copies of gene. Research efforts resulted in sharply increasing (by 10-15%) the content of proteins, zinc and ferrum in the grain by using a cloned version of the wild gene. This gene works through the mechanism of early ripening and speed transmission of nutritious substances from leaves to the grain.

By adding the identified part of the genetic code to the genome of traditional wheat, scientists hope to solve the problem of the deficit of zinc and ferrum from which more than two billion people are suffering all over the world (data from WHO). More than 160,000,000 children do not get a sufficient quantity of protein (Waters *et al.* 2009). “A new wheat variety will be rescued, providing people with protein and microelements,” Dubcovsky noted. “We are also developing a new variety which will reduce the quantity of parasitic substances in wheat that are disrupting the assimilation of useful ones. The substance is phytin acid, which reduces the assimilation of zinc and ferrum in the grain (Bielo 2006). ”

It is known that the microelement ferrum is the component of important proteins, including ferments, both haem and non-haem forms. The bulk of ferrum as haem enters into hemoglobin. In addition to ferrum in this form, it enters into the content of cytochrome P-450, cytochrome G5, cytochromes of the respiratory chain of mitochondrions and antioxidant ferments (catalase, myeloperoxidase). That is why this element is important not only for providing the organism with oxygen but also for the functioning of the respiratory chain and synthesis of

ATP, processes of metabolism and detoxification of endogenous and exogenous substances, synthesis of DNA and inactivation of toxic peroxide compounds. Ferrum regulates plants' respiration. Its deficiency leads to destruction of photosynthesis as well as chlorosis (lost of green color) of young top leaves. But sometimes shoots also suffer and are covered with brown spots (Allaberganova *et al.* 2011).

The microelement zinc enters into the structure of the active center of hundreds of metal ferments. It is necessary for the functioning of DNA and RNA polymerases controlling the processes of transmission of heredity information and biosynthesis of proteins as well as the reparation processes in the organism and ferments of key reaction of biosynthesis of haem, which enters into the structure of hemoglobin, cytochromes of respiratory chains of mitochondrion, cytochrome P-450, catalase and myeloperoxidase. Zinc enters into the structure of the key antioxidant ferment – (Zn, Cu) – a superoxide scavenger, and induces the biosynthesis of protective proteins of cell metallothioneins, and due to its power, zinc is an antioxidant of reparative action (2).

Zinc regulates cell circulation. Its deficiency is evident in highly expressed speckled old leaves, the appearance of dead tissue corners on them, and small leaves. A characteristic sign of zinc deficiency is a rosette line of fruit trees: there are very short internodes on the young shoots of the apple tree, but leaves at the end of shoot are collected into a socket.

Twenty-four wheat accessions were analyzed, including ancient and new wheat varieties, to test for microelements of ferrum and zinc, qualitative indicators of flavour, resistance to disease and productivity in the different conditions of growing. Tests were carried out in Tashkent and Khorezm Regions.

According to the data from the analysis of the content of ferrum and zinc in the wheat seeds grown on the selection plots, some ancient varieties (Kizil-shark, Kora-kiltik and Grekkum) and local commercial varieties Mars and Sanzar-8 have grains with ferrum of more than 100 mg per kg of flour. The relatively high content of FE was also revealed in the accessions Kizil-Kora and Yakkabog received from mountainous regions of Yakkabog district of Kashkadarya Region and in the local variety Emir created at the Institute (Graham *et al.* 1999).

It should be noted that the content of these microelements in some accessions exceeds the average indicators for winter wheat. The average content of ferrum in the flour was 38 mg/kg of dry substance (maximal content 70 mg/kg) according to data from Mineeva (1988). The content of zinc was 30-34 mg/kg per dry substance in flour made from winter wheat. Quantity indicators depended on the growing year; analysis made over two years on the zinc and ferrum content showed that they had fluctuated from 10 (for zinc) up to 35% (for ferrum).

According to data from specialists of the Institute of Nuclear Physics of Academy of Sciences of the RU, the content of Fe and Zn in the grain was 43 and 34 mg/kg. In the different varieties of flour selected from various sources (from different trade places of Tashkent – only 6 accessions) their content fluctuated from 22-62 mg/kg for ferrum and 5-12 for zinc.

It is likely that soil conditions (perhaps with greater content of Fe and Zn) of growing regions of some ancient varieties and accessions received from

Table 1: Content of ferrum and zinc in flour from wheat varietiesgrown under different ecological conditions (1-11 – in conditions of Tashkent Province, 12-24 – in Khorezm Province)

#	Variety name	Flour, harvest 2008		Flour, harvest 2007 from the plot of planting	
		Fe mg/kg	Zn mg/kg	Fe mg/kg	Zn mg/kg
1	Kizil kora boshok	38	35	97	39
2	Muslimka (beliy ost)	45	30	63	21
3	Kizil shark (high-growing)	42	26	142	27
4	Kizil shark (low-growing)	60	24		
5	Mars	34	33	123	31
6	Samarqand	45	29	80	32
7	Ulugbek – 600	36	29	119	22
8	Grekkum (krasniy ost)	41	28		
9	Grekkum (beliy ost)	36	31	101	37
10	Kora kiltik (Boysun t.n)	45	34	107	38
11	Emir	46	32	84	29
12	Moskvich	47	24		
13	Andijan – 2	54	26		
14	Kuma	54	24		
15	Dokha	70	31		
16	Esaul	52	31		
17	Polovchanka	43	29		
18	Pamyat	47	33		
19	Buz kala	45	26		
20	Tanya	45	24		
21	Nota	40	23		
22	Kroshka	38	21		
23	Krasnodar	86	27		
24	Valentin	41	24		

mountainous regions resulted in high accumulation of these elements in the wheat grain. In addition, the period of vegetation and temperature conditions (longer period of maturity stage and no high temperature in this period) in these regions can help increase the outflow of the nutritious elements as well as microelements from the leaves into maturing grain.

From presented data in Table 1, we see a wide spread of the content of these elements in flour – from 34 (Marc variety grown in Tashkent province) up to 86 mkg/kg of flour (Krasnodar variety, Khorezm Region). The content of Zn is more stable in the varieties grown in the different regions. Less Zn exists in Tanya, Valentin, Moskvich (Khorezm Region) and Kizil-shark varieties (Tashkent province), but more in the Kizil-kora variety – 35 mg/kg of flour.

It should be noted that the data show that varieties grown in Tashkent province contain less ferrum in flour than in similar varieties grown in mountainous regions of Surkhandarya and Kashkadarya, Andijan and Samarqand Districts. The growing plot does not affect the zinc content in flour from Kizil-kora, Kizil-shark, Mars Samarqand and Emir varieties. The difference in zinc content fluctuates from 4 up to 9 mg/kg in Muslimka, Ulugbek, Grekkum, Kora kiltik varieties.

Data on assimilation of ferrum and zinc in the grain of studied varieties after removal of the flag leaf on the various stages of ontogeny has been collected (Table 2).

Table 2: Ferrum and zinc content in the matured grain after removal of the flag leaf in three stages of ontogeny

#	Variety name	Flour	
		Fe mg/kg	Zn mg/kg
1	Kora kiltik (Boysun t.m; flowering)	40	31
2	Kora kiltik (Boysun t.m; milk maturity)	53	37
3	Kora kiltik (Boysun t.m; wax maturity)	53	39
4	Kizil shark (flowering)	35	35
5	Kizil shark (milk maturity)	43	37
6	Kizil shark (wax maturity)	39	43
7	Mars (flowering)	45	38
8	Mars (milk maturity)	46	33
9	Mars (wax maturity)	41	42
10	Muslimka (flowering)	45	39
11	Muslimka (milk maturity)	45	44
12	Muslimka (wax maturity)	52	46

In most cases, during removal of leaves in the flowering stage, ferrum content in the matured grains was lower (except for the Mars variety). Perhaps removal of the flag leaf in the early stage of maturity is negatively reflected in the entry of assimilates into the grain as well as the entry of microelements. Determination of quantity of ferrum and zinc in the flag leaf as the organ that supplies the nutritive elements of both organic and inorganic nature to reproductive organs was also carried out (Table 3). Ferrum content in the Kora kiltik variety in maturity (flowering/milk maturity/wax maturity) is increased, but zinc content is reduced.

As to other varieties, such assimilation of analyzed microelements in flag leaf was not observed. It should be noted that ferrum content in comparison with zinc content in leaves is more pronounced than in matured grains in all research stages. Further research is needed on the abnormally high content of ferrum and zinc in the flag leaf during the flowering stage of Kizil shark and Muslimka varieties.

Table 3: Content of ferrum and zinc in the flag leaf during different stages of development

#	Variety name	Leaves	
		Fe mg/kg	Zn mg/kg
1	Kora kiltik (Boysun t.m; flowering)	287	20
2	Kora kiltik (Boysun t.m; milk maturity)	301	14
3	Kora kiltik (Boysun t.m; wax maturity)	447	11
4	Kizil shark (flowering)	610	50
5	Kizil shark (milk maturity)	387	19
6	Kizil shark (wax maturity)	361	58
7	Mars (flowering)	193	52
8	Mars (milk maturity)	589	12
9	Mars (wax maturity)	335	40
10	Muslimka (flowering)	900	60
11	Muslimka (milk maturity)	278	13
12	Muslimka (wax maturity)	386	39

Biofortification, which is enrichment of grain with nutritious substances and microelements, assumes, primarily, the search for genotypes with high content of, in this case, ferrum and zinc microelements for further breeding and biotechnical manipulations in order to transmit this characteristic to cultivated varieties. It is necessary to note that such modifications of genotype of cultivated varieties should not be accompanied by worsening of economic indicators (yield, resistance to diseases and etc.) and food value of production (Polevoy & Salamatova 1991). According to our data on the varieties which are widely

cultivated in Uzbekistan and which were created recently, the content of these microelements is considerably lower than in the ancient varieties.

It should be noted that the content of fruit organs mainly depends on synthetic activity of leaves and the reaction ability of fruit organs (Polevoy & Salamatova 1991). In the maturity stage, grain is an acceptor of assimilates entering from matured photosynthetic leaves. Its photosynthetic function is slowed down when leaves become old and processes of hydrolyzes are strengthened, with the result that the leaf begins to supply low molecular units of azoth, phosphorus and microelements. In the authors' opinion, the result in cultivated wheat is that some functions of the gene were lost that led to the nutritional poverty of wheat grain. It is likely that the functional activity of this gene is retained in ancient varieties with increased content of ferrum and proteins that can open the possibility of transmission of this characteristic to cultivated varieties.

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ISSUES IN INFORMATIONAL MANAGEMENT OF COTTON GERMPLASM RESOURCES OF UZBEKISTAN

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Cotton is one of the most valuable agricultural crops in the world, particularly in Uzbekistan. It is necessary to note that intensive breeding processes aimed at the improvement of agronomic characteristics of agricultural crops, including cotton, has led to unintended exhaustion of their genetic basis over many centuries (Campbell *et al.* 2010). In turn the vulnerability of the majority of economically important crops to the different plant pathogens as well as environmental factors increased all over the world. Research and the establishment and maintenance of cotton genetic resources collections are of concern.

At the Institute of Genetics and Experimental Biology of the Academy of Sciences of the Republic of Uzbekistan there is a collection of cotton diversity unique in the world. The collection of cotton germplasm of Uzbekistan consists of more than 16,260 different accessions of cultivated species and subspecies of cotton, among which more than 7500 are the cotton collections of the Institute of Genetics and Experimental Biology of the Academy of Sciences of the RU that were collected from all over the world. This collection is the most complete and richest one with regard to the diversity of wild species in our region and the world. However the management and documentation of these accessions do not meet the global standards suggested by Bioversity International among others (Alan *et al.* 2006); most information about the accessions in the Uzbek collection is kept in the form of journal notes and separate electronic tables. This considerably complicates and delays the work on the collection, while in foreign countries the same information is actively transmitted into digital format and entered into databases (http://cottondb.org; http://gossypium.info; http://tropgenedb.cirad.fr/en/cotton.html).

Intensive research on cotton is implemented in Uzbekistan as well as in different scientific institutions around the world. This research is often carried out in cooperation with other institutions and with regular exchange of seed material and in this connection a big volume of information has been collected. There is thus a necessity to provide simple and quick access to these resources by multi-stakeholders (scientists, breeders, seed-growers, agronomists and farmers and other organizations).

It is necessary to note that in Uzbekistan and in number of other countries, selection of variety accessions and linear material of cotton for use in breeding tasks are being performed, as a rule, on the basis of heuristic knowledge and intuition. The necessity of the establishment of informational system in cotton breeding is indicated since a huge amount of breeding material has been collected in the Republic. Work on such a large volume of information requires an appropriate solution. For management, research and access to information about collections to optimize the breeding process and implementation of concrete productive tasks while choosing this or that variety, it is necessary to develop a general database based on unified descriptors of cotton with full information about characteristics (origin, sign totality, parameters, etc.)

Information about characteristics should be documented so that breeders can identify potentially useful accessions for effective use of the germplasm collection. That is why data on descriptors should be computerized and form part of a convenient system for research and evaluation of information. It is necessary to develop the methodological aspects of database formation in the context of the Uzbek collection of cotton germplasm so as to solve this problem.

We propose the development of a broadened system of description of cotton characteristics and the creation of a database for cotton descriptors in order to regulate and manage all collected information. Users can choose a suitable programming language for the solution of new types of issues and select an appropriate set of different methods, presented in existing module sets and pertinent to the objective. The genetic resources can be examined on the basis of their characteristics in terms of status and behaviour. For example, cotton can be characterized (variety, color, height of plant etc.) and evaluated (profitability, populatiry of the variety, level of representing of traits depending on growing conditions). Outputs of this research allow a considerable facilitation of access to and data retrieval from collection accessions of potential interest and with the required parameters.

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RADIATION METHOD FOR ACTIVATING POST GRAFTING NEOGENESIS IN PERENNIAL PLANTS

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The issue of the biodiversity of perennial plants is associated not only with their conservation as genetically unique organisms but also with creating conditions allowing their use in practical agricultural production of rare and endemic varieties. In this respect it is highly important that the cultivation of perennial crops requires the solution of a number of practical problems, in particular, that of obtaining high-quality grafted material. In turn, this is closely related to such phenomenon as tissue incompatibility of grafted components and their poor concretion (or rejection) (Bulakh 1980). To improve the quality of concretion in transplantation we proposed a radiation method for activating post-grafting neogenesis in perennial plants. We used Georgian grape endemic varieties as biomodels during the study. This choice was determined by the fact that they are characterized by high levels of callus formation and a variety of species. During the study, grafted components were irradiated with a gamma radiation dose of 7.5 Gy. This dose is used as for stimulating callusogenesis (Gogebashvili 2009). After stratification, grafted plants were grown for eight months on experimental plots. Analysis of concretion quality was made on histological sections of the grafting zone (Fig. 1).

The research data presented in the Figure 2 demonstrate that the use of gamma irradiation before grafting results in a trend toward reduction of anatomical defects of concretions associated with the callus of parenchymal cells with relatively minor changes in the number of other species causing low-quality concretion of grafts.

Giving detailed consideration to the reasons for occurrence of parenchymal tissue in the area of concretion, it should be noted that this phenomenon has great biological significance from the perspective of a protective response on the part of each of the grafted components. First of all, it performs an insulating role as a means of protection of basic, normally functioning tissues from possible rotting inside the joints. However, the parenchymal tissue itself adjacent to the area of the conduction systems shows some irregularities in the concretion associated with cyto-differentiation as formation and functioning of the elements of the conduction system are indicators of the normal course of regenerative processes in the given area.

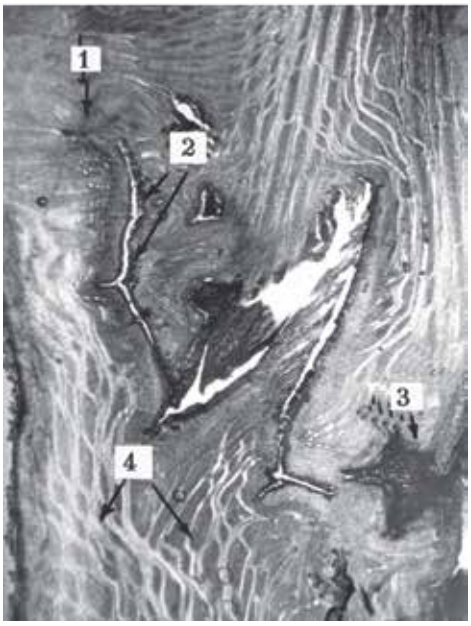

Fig. 1 Histological picture of various types of anatomical and histological defects of grafts concretion zone (longitudinal section) 1- “callus”; 2 – «gorge»; 3 – necrosis zone; 4 – Conductive vessels.

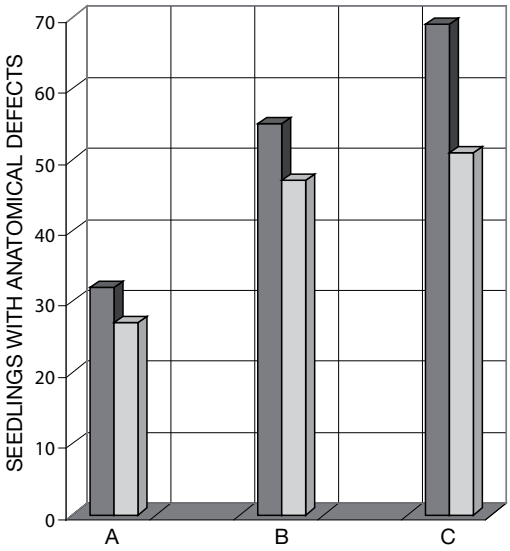

Fig. 2 Action of gamma irradiation on qualitative composition and change in graft number with various types of anatomical and histological defects of concretion. A – “gorge”, B – necrosis zones, C – “callus”, Dark histogram – control,

It is commonly known that cyto-differentiation of callus cells in the zone of graft concretion is a complex process associated with homogenetic induction. This process shows up under the influence of differentiated tissue from cutting on the callus cells, “transferring” its direction of cyto-differentiation to them. Thanks to homogenetic induction from grafted components, vascular bridges occur in the callus and parenchyma that connect conductive vessels of the graft and the stock (Libbert 1976). Moreover, due to lack of cyto-differentiation, other anatomical defects of concretion may develop. This is also evidenced by the fact that the parenchymal calluses are often associated with other anatomical defects along with poor quality of graft concretion.

In general, anatomical and histological studies conducted on the concretion zone of grape grafts showed that gamma irradiation has a positive effect on the quality of seedling concretion. One of the most promising mechanisms for improving the quality of grafts concretion using irradiation is the impact on the process of cyto-differentiation.

On the whole, the findings may indicate that pre-grafting gamma irradiation can be used as a factor in the impact on concretion of grafted components of various endemic and rare perennial plants. This method can significantly facilitate the success of grafted seedlings of such grafted components that are not normally capable of producing viable grafted plants.

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MODERN POSSIBILITIES OF APPLIED AEROSPACE TECHNOLOGIES FOR CONTROL OF THE STATUS OF UZBEKISTAN'S ECOSYSTEMS AND SOLUTIONS OF PROBLEMS IN BIODIVERSITY CONSERVATION

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Increasing anthropogenic effects on nature destroys existing ecological balance that leads to the disappearance of many species of plants and animals and to the annihilation and destruction of natural ecosystems. One of the critical problems of biodiversity conservation was identified by international organizations in the past century and resulted in the elaboration of the Convention on Biological Diversity (CBD), which Uzbekistan joined in 1995. The main results of the national strategy and practical activity on the study and protection of flora and fauna of the separate territories are stated in the CBD (Tashkent 2006).

The study of evolutionary processes in ecosystems on all levels requires regular analysis of objective data regarding the various environmental parameters. Operative information on the state of biodiversity should allow the timely correction of the effects influencing biosystems directly as well as the social and economic processes caused by these effects. The variety and complexity of monitored variables, as well as differences in landscape and ecological conditions in the different regions of Uzbekistan impose additional demands for necessary ecological data for collection systems. In this context, increased access to and completeness of data from Earth Remote Sensing (ERS) systems on the environment, the creation of a computerized database of geobotanic descriptions and the development of GIS technologies open new possibilities for determining the state of the ecosystem for solving problems of biodiversity conservation.

Applied aerospace technologies (Earth remote sensing, global satellite navigation, satellite telecommunications) are without peer in terms of smartness, accuracy, quantity of information and economic efficiency in issues of ensuring complex security and identification of natural and anthropogenic threats to civilization . Systems of ERS and GIS technologies provide a wide-scale and objective method for determining the effect of natural and anthropogenic processes on the degradation of the environment, including desertification, salinity, destruction of woodlands, pollution from harmful emission and wastes and monitoring of sources of atmospheric, water and soil pollution. This provides a framework within which to discuss problems of emergency situations of technogenic and natural features.

The main sources of satellite information are existing data from research on land, water and atmosphere from free-access satellites Terra, Aqua and Aura within the framework of the **EOS** (Earth Observation System) program (NASA). Adjusted sensors allow the reception of practically all necessary ecological information as well as high resolution. The cosmic radiometer of thermal radiation and reflection **ASTER** combines a wide-spectrum coverage and high resolution space survey in visible, near infra-red (NIR), middle infra-red (MIR) and thermal infra-red diapason. A hyper-spectral, 36-channel survey in the diapason from 0.45 to 14.36 m with a resolution of 250-1000 m (**MODIS** sensor) and pollution measurement of the lower layers of the atmosphere in three spectral diapasons (2.3, 2.4, 4.7 mkm, **MOPITT**) were carried out and they revealed sources of entry, dissemination, transfer and precipitation of carbon and methane oxide in the troposphere. This and other transmitted satellite data is widely used and largely sufficient for the study of the dynamics of vegetation and ecosystems at the different levels, the monitoring of natural disasters as well as research on geological, soil, climatic and hydrologic data and the study of land modifications. A global database and a computerized informational network (**EOSDIS**) were established for processing, preserving and disseminating satellite research within the framework of **EOS** program.

There is also open source data from radar altimetry that is necessary for building 3-D models of the area as well as for archive photographs of high resolution from other specialized satellites ERS (Landsat, Quick Bird, IRS, CALIPSO and others).

It is advisable to use the practices established by international programmes for the development of indicators and criteria for the evaluation of biodiversity, scales and evaluation levels in order to compare data and standardize approaches (FAO 2009, Quebec 2009). Generalizations of multi-level biodiversity characteristics are based on methods of quantitative analysis combining data form land use research and spectral details of space images from GIS technology. The method of statistical interpolation of dot values of vegetation characteristics is used more often on the basis of qualitative analysis of ERS and digital models of contour relief.

The system of spatial, spectral, attribute and other types of analysis within the program sphere of ArcGIS was developed to carry out the processing of the land and satellite data. Many powerful functional models from the systems of ArcGIS (Spatial Analyst, ArcView, ArcEditor, ArcInfo, ArcMap) used for ecological research, exist in the open source realm.

An important condition for the successful adaptation and introduction of ERS and GIS technologies is the presence of qualified specialists and experts in this sphere. While the situation with regard to expertise in this area in the Republic is at present not satisfactory, there are some factors that can facilitate resolution of this problem. A new educational discipline on applied cosmic technologies was established at the Tashkent State Technical University in 2011 for preparation of specialists in this field. Experts with masters and doctors degree are trained at the Educational Center of UNO on aerospace sciences and technologies for ATR (India) under financial support from the Government of India and the Department of UNO on aerospace activity. A GIS portal provides textbooks and practical

manuals on ERS use and development of GIS projects through distance education and advanced training. Mechanisms for mediation of CBD issues envisaging the development of national potential in this field allow the establishment of curricula and a probation period for specialists in foreign centers, as well as the organization of educational workshops in Uzbekistan to which international experts are invited.

There are thus all the necessary prerequisites for mastering and using applied aerospace technologies in Uzbekistan, first of all ERS and GIS, in order to monitor the state of the country's ecosystem and to solve the problem of biodiversity conservation.

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AEROSPACE TECHNOLOGIES IN MONITORING OF AGRICULTURAL CROPS

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Agriculture is one of the promising areas for the use of data from Earth Remote Sensing (ERS) technologies. This data can be used to contribute to increasing the intensification of animal and especially plant production. Remote sensing can be a relatively inexpensive source of data about early stages of vegetation and is useful in the evaluation of yield of agricultural crops, cotton in particular, as well as for research on modifications in productivity, degradation and salinity of land. It should be noted that China, the USA, India, Australia and Uzbekistan are five of the main world producers of cotton, (producing altogether 75% of the global yield in this crop), but information systems on the monitoring and technical management of cotton cultivation integrated with data from remote sensing, were developed and introduced in all these countries except Uzbekistan.

The first efforts using ERS data were begun in USA in 1973 and in 1986 a system of global monitoring of growing conditions and evaluation of the yield of the main agricultural crops – cereals, legumes and cotton—was launched on the basis of a joint programme involving NASA (the US National Aeronautics and Space Administration), National Oceanic and Atmospheric Administration (NOAA) and the Department of Agriculture of the USA called AgRISTARS (MacIDonald & Hall 1986). This system based on ERS also allows practitioners to forecast the production of these crops in Russia, Canada, Mexico, Argentina, Brazil, China, India and Australia, giving the USA serious privileges in the political economic area.

Soon after the AgRISTARS system was established, the United Research Center of the European Union established its own system of yield evaluation CGMS (yield evaluation systems of the European Union) through the program "MARS" – ERS for monitoring of agriculture. This system was disseminated in all countries of EU and widely used in the political economy to determine general yield for market forecasts, flexible planning of agricultural subsidies and checking farmers' declarations (Supit *et al.* 1994). At the end of the last century, the same systems were established in most developing countries as well as in China and India based on ERS satellites of the IRS series (Wang *et al.* 2004). At the same time, FAO (the Food and Agriculture Organization of the UN) established GIEWS – Global System of Information and Early Forecasting of Food and Agriculture

for monitoring agriculture in African, Asian, South American and Caribbean basin countries. GIEWS uses 10-day integrated data of space images from satellites showing SPOT (name of satellite for remote sensing) and NDVI (vegetative indexes: combination of satellite pictures of the studied area, received through different spectrial channels) processing in the special program WINDISP (special software for processing snapshots from space) (FAO 2011).

In spite of their variety, all systems of distance monitoring of agriculture use three main models (Roberto 1993):

- straight model based on the analysis of vegetative indexes (NDVI, RVI, PVI) and the ratio of plant reflection at the various spectral bands. This method is convenient for deciduous crops of the cotton type, is simple to use and requires less ERS data;
- classified model based on the establishment of a number of types of standards (classifications) which connect different productivity of agricultural crops in selected farmlands with their differences in the reflection spectrum;
- comparative model (in the same period of different years) where long-term statistical data of productivity and information of ERS is used.

Other important areas of aerospace technology application is the agriculture based on the existence of heterogeneity within the limits of one field. A global positioning system (GPS, GLONASS), proximate analyzers of soil, portable detectors of plant spectrums and space images are used for evaluation and detection of these heterogeneities. The collected data is integrated into the special programs for agronomy management on the basis of geoinformational systems (GIS) and used to evaluate the optimal density of planting, calculate the local norms of fertilizer application and means of plant protection, make precise irrigation calculations, make more reliable forecasts of yield and financial planning. This aim is supported by the UN (FAO) in every possible way (FAO 2011). The UN recently announced a new initiative aimd at the ecologically stable intensification of agricultural production, rendering small farmers assistance in the reduction of productive expenses and the establishment of healthy agricultural ecosystems.

This technology is especially important for planting cotton since large-scale and unbalanced application of mineral fertilizers and pesticides has undermined natural biological processes and led to the reduction of fertility. Plants do not assimilate more than 30% of phosphorus and potassium fertilizers, or more than 50% azoth fertilizers applied on cotton fields and they also wash off into rivers with non-dissociated chemical weed and pest killers widening the area of soil and water pollution.

In Uzbekistan a number of projects carrying out research on salinity have already been completed in Djizakh Region. These projects created maps of salinity by means of the analysis of aerial photos and space images, selected pilot projects on the identification of different agricultural crops in the selected regions based on space images, and performed the evaluation of vegetation by ERS (Rukhovich et al. 2010). While these research projects were carried out within the framework of scientific and applied programs and international grants, there are prerequisites for mastering global practices on the practical

use of ERS and GNSS technologies in the agriculture of Uzbekistan. We should realize that aerospace technologies provide an optimal means of managing and monitoring crop cultivation on every square meter of fields and allow the maximum generation of income while saving economic and natural resources. The conditions discussed in this paper should serve as a powerful impetus on all levels of agricultural planning and management.

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METHODS OF MULTIPLICATION OF FRUIT CROPS ON FARMS

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Horticulture is one of the main branches of agriculture in the Republic of Tajikistan. It is necessary to rationally use every plot of land in conditions of smallholder farms and irrigation agriculture. Difficulties were faced by dekhkans (peasants) and farmers during the transition of the agricultural production sector to market relations.

During the transition period, farmers have had to become technologists, agronomists, sellers of their own goods, and knowledgeable in marketing and client research as well as in many other areas. In this connection land in Tajikistan has become the private property of *dekhkans* and farmers. For this reason, there is a need for producers of planting material such as high-quality seedlings of apricot, apple tree, quince, pear, peach, walnut, pistachio, almond, lemon, tangerine, orange, persimmon, grape, strawberries, sea-buckthorn and other fruit-berry crops.

Seeds are natural and biologic products which appear after fecundation of seed-buds having maternal and paternal cells. A seed is an organ of multiplication of the plant. Plant grown from seed is called seedling or root-stock. Seed multiplication is used limitedly and used mainly during the growing of seedlings. Seedlings of fruit crops are variable in terms of many properties as well as fruit quality. During multiplication of cultivated varieties with seeds, progeny in most cases give fruits of worse quality than the mother plant. While breeders' experience shows that fast fruitening of seedlings is closely related to the level of early fruiting and productivity of their parents, as a rule, mass seed progeny enter the fruiting phase later than grafted trees. It is necessary to follow the following rules to derive productive trees from seed multiplication. Fruit crops are multiplied in two ways:

- from seeds, i.e. with generative organs;
- from cuttings, parts of roots, shoots, off-shoots, budding, special organs, i.e. vegetative organs.

It is known that "demand determines supply" expresses the market, which is why the quantity of seed material is annually increased, although on the other hand, the phytosanitary and biological quality of growing seedlings are worsened. Dangerous viral and mycoplasmic diseases transmitted in multiplication are found on seed materials. Means of improving the genetic, biological and technical quality of seed material include healthy measures such as:

- initial selection;
- laying super elite mother gardens;
- growing elite (qualified) seed material.

At present, not only farmers but also many specialists have insufficient information about the influence of seed material on garden productivity. Not having such information, buyers do not have specific requirements while buying seedlings at the market.

Long-term experiences of the author in Sughd Region under various soil and climatic conditions showed that planting of fruit crop seeds on permanent plots and further budding with growing buds (June-July) and sleeping buds in August gives the possibility of having early fruits from trees in the garden. On farms there are also other more economical ways of growing seedlings (plants), i.e. in pots. Our experiences show that cheaper and more convenient pots can be made at home from normal polyethylene film using iron. Soil mixture for seed planting can be normal loose fertile soil, decomposed manure or soil in equal proportions, humus, pieces of straw and small-grained river sand.

Before planting it is advisable to water the pots abundantly and then put 3-4 seeds into the soil mixture and cover with a 1.5-2.5 cm thin layer of loose soil. Seedlings should be 10-15 cm at the age of 30-35 days before planting them on the permanent plot. This gives the possibility for intensive growing, and healthy seedlings for budding in early spring. All this work is carried out in a warm place where it is easy to manage the process and cultivate the seeds. The success of seed multiplication depends on observation of the following conditions:

- seeds should produce plants of the specific variety that was planned to grow;
- seeds should be germinating, uninfected, providing adequate biological and phytosanitary quality of seed material (seedling);
- the farmer should know about seed storage, conservation, the processes occurring in seeds during their preparation for growing, the duration of the stratification period, and monitoring of germinating seed;
- proper conditions for growing seeds should include the right humidity, temperature, access to oxygen and light;
- care should be provided after seeds sprout in the permanent plot to obtain healthy seedlings.

Vegetative multiplication does not change the genetic content of a new plant. All traits of the maternal plant are transmitted to the daughter plant and the exact reproduction of the set of chromosomes is observed during cell division. For instance, planting of stone (seeds) of apricot of the Kandak variety produces a new seedling, but it will be not the Kandak variety but a new (hybrid) variety without name and with a bad quality. For conservation, the Kandak variety should be multiplied in the vegetative way using budding, grafting, off-shot, cuttings, tendrils, roots, leaves, spears, one cell tissues or other vegetative organs.

Budding is the art of connecting two or three plant parts so that they grow firmly and continue their growing as one plant. A number of budding methods exist, which can be divided into three types:

- budding to the rind;
- chip budding;
- budding with a pipe.

During budding to the rind in the period of active formation of plant tissue, when the rind is removed from the wood well, a T-type section of the rind is made on the root-stock, its corners are raised a little and a small line is placed with a thin layer of the wood (cyme) of the scion with bud. Thus the cyme of the scion sits under the rind of the root-stock. After demonstration of the first technique of budding and fixing, the instructor explains other techniques. During chip budding, which can be made without separation of the rind on the root-stock, the narrow rind line and wood are cut, the same sized line of tissue of the scion (cyme with bud) are set in its place. For ensuring successful grafting, the place of budding is made through one of many techniques, and is tied to prevent the scion from drying out and provide a dense contiguity of the grafted parts. In farms the seedlings could be grafted with the desired variety by using a grafting technique with a ring ("Naychapayvand") or grafting with a pipe. A ring of rind is removed fully and replaced with a ring of rind from the cutting to produce a new growth of cultivated shoot on the root-stock from the bud. For the correct combination of parts, root-stock and scion should be approximately the same size.

Other ways of budding can also be used in the gardens, for instance, compatibility of varieties (quince and pear) is improved with budding with intermediate fixing (method of approximation with double budding). In this case compatible and incompatible varieties are on two "feet", then one of them – the incompatible one—is removed. Budding with two or three buds can be made to increase the life of the seedling. During this budding, initial material is spent economically; every bud (eye) has potential for a new plant formation of the desired variety. Besides, the budding technique is very simple and can be mastered easily by every dekhan. For many centuries many ways of grafting have been created by skilled horticulturalists and have been improved and had new elements added over the years. The advantages of grafting as compared to budding is that cuttings begin to grow in 15-20 days, which is why it can be done in winter before sap flow start.

A normally developed tree can be formed in the year of grafting and produce an early harvest at the age of 2-3 years. Multiplication with cuttings is the most popular method of vegetative multiplication, using off-shoots, soboles, root cuttings, green and timber cuttings, caulescent cuttings, tendrils and leaves. Herewith, a newly grown plant as mother plant bears fruits earlier than one grown from seed.

Although new plant formation happens quickly and without damage, it is important to support the technology of garden establishment. In addition, the dense location of cuttings from 100 to 300 units per 1m^2 with high percentage of rooting provides a large quantity of plants from one area, good rooted plants, good hardiness and high productivity as well as longevity and capacity for self renewal in case of desiccation or freezing of the over ground parts of the tree.

In multiplication of fruit plants with green cuttings, a biological basis is the capacity of young, non timber shoots to form adventitious roots; shoot growing is implemented at the expense of the development of existing buds.

Rose, sea-buckthorn, grape, raspberry, currants, plum and cherry-plum are easily multiplied with green cuttings in comparison with other plants. Permanent moistening, a good access to oxygen and a high temperature are required to grow plants. Under farm conditions they are provided independently in the greenhouses. A greenhouse is invaluable for the farmer. A simple form of greenhouse is glass or a frame covered with film placed under a shallow dish of 70-75 cm.

It is necessary to prepare the substratum for good rooted cuttings in the greenhouse. The lower part , the drain layer, consists of small broken stones or pebbles. Then fresh manure of 10-15 cm is placed on the upper part. The third layer is fertile soil 15-20 cm thick, and a layer of large-grained river sand of 10-12cm is placed on the top. Green cuttings from trees are prepared when shoots are in the phase of active growing. Too herbal cuttings with a hard timber are not suitable. Cuttings are made in a length of 10-12 cm. Two laves are left and the lowest one is removed if it disturbs planting.

It is necessary to process the cuttings with growth promoters for rooting to increase the percentage of root formation (indole oil acid (IOA), indole acetic acid (IAA), heteroauxin, and others). A more universal and effected remedy is IOA. Before planting of cuttings, the substrata is carefully equalized, easily condensed, moistened and then cuttings are planted at the depth of 3-5 cm and substrata is pressed around them. The distance between cuttings in rows is 3-5 cm, between aisles 5-7 cm, defined by the size of leaf. Density of planting is 300-450 units of cuttings per 1m^2.

The optimal temperature for cutting rooting is 24-30°C. Humidity is the main factor on which the rooting of cuttings depends. Relative humidity of the air under temperatures in range of 20-25ºC should be 80-85% in the greenhouse. In orchards this is reached in the first days of irrigation with intervals of 45-50 min. The first 5-7 days the surface of the leaf should be provided with a thin layer of water. In this case roots are formed on cuttings within 18-25 days. The first additional fertilizer is applied with 2 g per 1m^2 of azoth and 2.5 g per 1m^2 of phosphorus and potassium within 3-4 weeks after planting until the moment of mass formation of roots when film coverage is removed.

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Section 3.
DEVELOPMENT OF CAPACITY AND TRAINING IN ISSUES OF STUDY, CONSERVATION AND MANAGEMENT OF AGROBIODIVERSITY

INTEGRATING AGROBIODIVERSITY INTO HIGHER EDUCATION CURRICULA –AN INTERNATIONAL OVERVIEW [1]

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Introduction

Interactions between humans and nature over millennia have created a very rich diversity in species and varieties used for food and agriculture. This diversity is concentrated in the Vavilov Centres of Diversity where species were first domesticated. Central Asia is one or those, the origin of grains and legumes such as common wheat and lentils; fibres such as hemp and cotton; vegetables including onion, garlic and carrot; and a range of fruits and nuts including pistachio, walnut, almond, apple and more. The genepool of such species consist of local landraces conserved *ex situ* in genebanks or *in situ* and on farms, improved varieties, but also wild relatives in natural ecosystems.

Globally, agrobiodiversity is under pressure due to a range of processes including population growth and demographic change, intensification of agriculture, land conversion and degradation, and changing food habits and markets. Hence the need for conservation efforts that maintain the options for future generations and allow species and ecosystems to evolve and adapt to changing conditions, including climate change (CBD 2011).

The agriculture sector will need to increase global output by 70% by 2050 (FAO 2009) and also shift towards a healthier food system, while simultaneously sustaining ecosystem services, including mitigation and adaptation to climate change. This will require sustainable intensification of agricultural systems (World Bank 2008). For such sustainable intensification to take place at a large scale, attention is required to the scaling-up of successful processes and lessons (Pretty *et al.* 2011).

Agrobiodiversity provides the genetic materials for this intensification in breeding or value addition. At the same time, agrobiodiversity is essential for sustainability of agroecosystems because of its provision of ecosystems services and the continued adaptation and evolution that takes place in such ecosystems. Given the importance of agrobiodiversity and the need for human capacity to understand and manage agrobiodiversity processes, it is perhaps surprising that curricula of agricultural higher education institutions rarely cover the subject comprehensively. Few universities offer courses or programmes

1 Presented at: International scientific wrap-up conference on conservation and sustainable use of fruit crops and wild fruit species, 23 -26 August 2011, Tashkent

on agrobiodiversity, as consultations with universities in Africa, Asia and Latin America have shown.

The good news is that the interest is rising. There are signs of growing demand for knowledge, guidelines and training materials that would assist universities in integrating agrobiodiversity into their courses and programmes. This paper gives an overview of recent lessons, initiatives and resources for strengthening agrobiodiversity education globally, suggesting that these experiences might be applicable also in Central Asian higher education institutions.

Agriculture education and diversity

It is not surprising that commodity crops dominate agricultural higher education curricula today. This simply reflects the prevailing focus of agricultural policies, markets and research on a very limited number of agricultural species that provides most of our food (Figure 1). Furthermore, within species, there has been a rapid change towards growing a limited number of commercial varieties, with a corresponding decline in the cultivation of traditional varieties. Yet these traditional varieties, along with a range of neglected and underutilized species (NUS) remain very important, particularly in marginal environments. NUS and landraces, including their often informal seed systems, are however poorly covered in higher education.

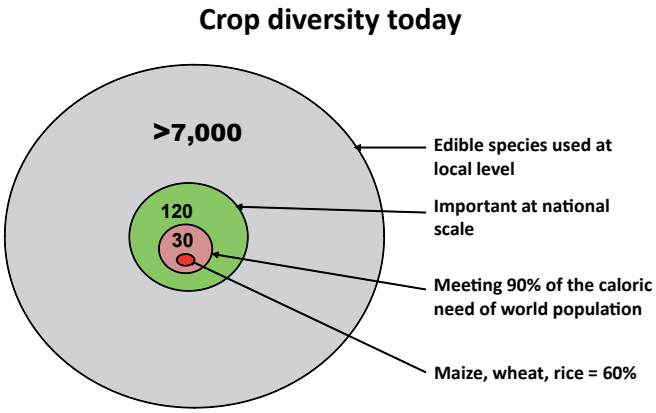

Figure 1. Crop diversity today (Wilson 1992)

The focus on commercial crops in agricultural education leaves some important gaps in curricula regarding the conservation and use of a broader spectrum of agrobiodiversity, such as:

- value chains of neglected and underutilized crops (NUS);
- impact of climate change on agrobiodiversity, and the role of agrobiodiversity in mitigation of and adaptation to climate change;
- links between agrobiodiversity, and food and nutrition;
- ecosystems services of agrobiodiversity;
- private-public partnerships;

- international treaties and protocols on plant genetic resources and agrobiodiversity;
- agrobiodiversity conservation *in situ* and on farm;
- farmers' local/traditional knowledge, including gender dimensions;
- participatory approaches to agrobiodiversity conservation and use.

Many of these aspects involve both biophysical and socioeconomic sciences, and cut across sectors. For Central Asian fruit trees, the management of the gene-pool involves at least three sectors: forestry, agriculture and horticulture (Figure 2). In consequence, the ability to manage multi-sector and multi-disciplinary processes is critical to agrobiodiversity learning.

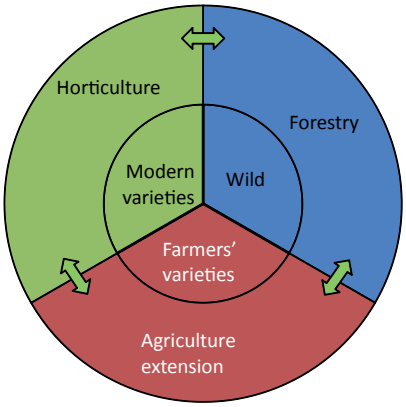

Figure 2. Genepool of fruit crops in Central Asia is managed by multiple sectors

How is agrobiodiversity taught?

Bioversity International and partner universities and international organizations organized regional consultations in Sub-Saharan Africa, and East and Southeast Asia in 2009 and in Latin America in 2010 to review the status of agrobiodiversity education and to outline strategies for improvement. Prior to these consultations, surveys of selected universities in Sub-Saharan Africa and Central America were also conducted.

A 2007 survey of 10 African universities in Kenya, Malawi, Uganda, Zambia and Zimbabwe found the following patterns and trends:

- no dedicated courses or programmes on agrobiodiversity in any of the universities;
- there was a focus on specialized programmes on seed science, crop protection, horticulture, microbiology, and agronomy, with emphasis on commodity crops;
- a few universities offered relevant broader programmes, such as MSc Ethnobotany at Kenyatta University and BSc Agroecosystems and environment at Nairobi University;

- some programmes and courses dealt with conservation ecology, environmental impact assessment, landscape restoration and the like;
- curricula on biotechnology, bio-informatics, genomics, etc., are becoming more popular.

Although many courses included isolated topics of relevance to agrobiodiversity, a more holistic, systems-oriented coverage was lacking. Courses and programmes that tackle agrobiodiversity from a multidisciplinary, multi-stakeholder and multi-scale perspective are, by and large, absent (Van Schagen 2009).

In Latin America, a case study on agrobiodiversity in higher education in Costa Rica and Mexico was conducted (Vasquez *et al.* 2010). In a conference session, Bioversity, the Tropical Agriculture Research and Education Centre (CATIE) and six universities in Mesoamerica then discussed the status agrobiodiversity in university curricula and how to move forward. The conclusions reached were as follows:

- The job market for agrobiodiversity-related graduates in Mesoamerica is perceived as limited and is reflected in low enrolment.
- Within universities there tends to be limited support for or awareness of agrobiodiversity. The topic is currently not well understood in all its dimensions and its benefits are not fully recognized. Agrobiodiversity is therefore neglected by university authorities as well as by politicians.
- As a multidisciplinary field of study, agrobiodiversity education requires collaboration that crosses traditional institutional boundaries. Currently, collaboration within a faculty is common, but broader internal and external alliances are required, particularly with research organizations of different kinds.
- Education needs to be well connected with communities and rural producers to be relevant and focused on solving real-world problems in a participatory way.

In summary, this broad review of global agrobiodiversity education revealed that:

- Agrobiodiversity is rarely offered as a stand-alone course or full programme, partly reflecting a perceived lack of clear career opportunities for graduates.
- The concept of agrobiodiversity is not well understood among students, or even educators.
- Very few educators have been trained in the area of agrobiodiversity.
- There is a lack of integration of agrobiodiversity across sectors and insufficient integration of scientific and local/traditional knowledge .
- Rigid existing curriculum structures may hinder the uptake of a new topic such as agrobiodiversity.
- Few subject-specific learning resources are available.
- Better links between training, research and practice, and between universities and conservation organizations and would stimulate uptake of the subject.
- National and international policies on agrobiodiversity are still not well known in the national agricultural research and extension system, and capacity for implementation is weak. This also influences the way universities teach the subject.

- New agrobiodiversity-related policies create new opportunities for universities to act.
- Education needs to be relevant and focused on solving real-world problems in a participatory way, which requires good connections with communities and rural and urban producers and consumers.
- There are signs that universities are increasingly interested in developing agrobiodiversity courses and programmes (Rudebjer *et al.* 2011).

Opportunities for enhancing agrobiodiversity education

The awareness of, and the interest in, agrobiodiversity is increasing in all regions, also reflected in several recent regional conferences:

- The conference '**Agrobiodiversity in Mesoamerica – from genes to landscapes**', held in Turrialba, Costa Rica in September 2010, aimed to strengthen the use and management of agrobiodiversity and promote sustainable land management in Mesoamerica.
- An **International Symposium on Sustainable Agricultural Development and Use of Agrobiodiversity in the Asia-Pacific Region** was held in October 2010, in the Republic of Korea. The conference adopted the Suwon Agrobiodiversity Framework, which aims to provide a strategic approach towards both management and use of agrobiodiversity, through collaboration and partnerships among stakeholders (APAARI 2010).
- The launch of the **Agrobiodiversity Initiative for Africa** (ABIA), by the Forum for Agricultural Research in Africa (FARA) and Bioversity International, in July 2010, in Burkina Faso.

These international forums all recognize the need for developing adequate capacity for the conservation and use of agrobiodiversity and for implementing relevant policy processes, such as the Convention on Biological Diversity (CBD) and the International Treaty on Plant Genetic Resources for Food and Agriculture.

Table 1. Curriculum development initiatives on agrobiodiversity

University	Course or programme
University of Peradeniya, Sri Lanka	3 courses on crop wild relatives conservation
Universidad Nacional de Colombia, Colombia	Pilot course on agrobiodiversity approved
Tribhuvan University, Nepal	MSc course on agrobiodiversity management under development
Scuola Superiore Sant'Anna, Italy	PhD Programme in Agrobiodiversity
South Eastern University College, Kitui, Kenya	Range of agrobiodiversity courses and programmes under development at BSc and MSc level

Actions to strengthen agrobiodiversity education have already started. In Sub-Saharan Africa, a Task Force on Agrobiodiversity Education, set up in 2009, was requested to develop a curriculum guide on the subject. In East and Southeast Asia a regional action plan was agreed upon in 2009, which is guiding universities in the region in their enhancement of courses. A number of universities have also started curriculum development initiatives (Table 1).

Agrobiodiversity curriculum framework

Building on the experiences and insights gained via these surveys and international consultations and conferences, Bioversity and its partners in the Task Force on Agrobiodiversity Education developed a curriculum guide for universities interested in integrating agrobiodiversity into courses and programmes. The resulting publication, **Teaching agrobiodiversity: a curriculum guide for higher education,** discusses key issues in agrobiodiversity education and presents a curriculum framework of 14 topics central to agrobiodiversity processes, conservation and management that are grouped under four areas (Figure 3).

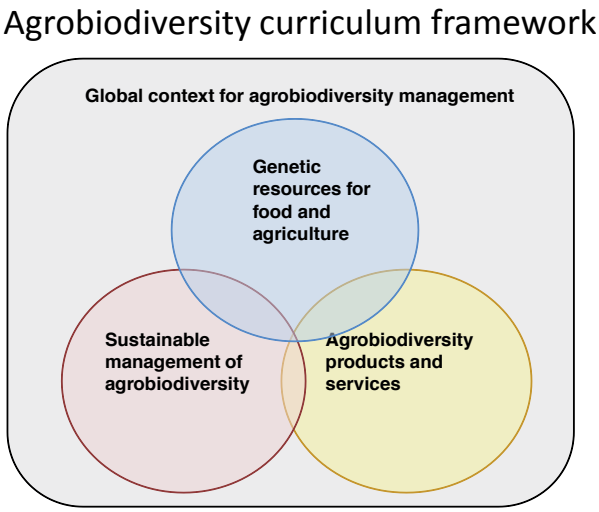

Figure 3. A framework for agrobiodiversity learning

These four broad areas of agrobiodiversity learning are further sub-divided into 14 proposed topics.

Global context for agrobiodiversity management

- global change and agrobiodiversity;
- impacts of climate change on agrobiodiversity;
- policies for agrobiodiversity conservation and use;
- institutional aspects of managing agrobiodiversity.

Genetic resources for food and agriculture:
- processes shaping agrobiodiversity;
- status and trends of agrobiodiversity;
- conservation of genetic resources.

Agrobiodiversity products and services:
- agrobiodiversity and livelihoods;
- food and nutrition systems;
- traditional knowledge;
- environmental services.

Sustainable use of agrobiodiversity:
- farmer's seed systems and participatory breeding;
- on farm conservation and management of agrobiodiversity;
- value chains of neglected and underutilized species.

Each topic is briefly introduced along with key learning points, suggested contents, a bibliography and a list of internet resources. The Guide is flexible to fit a range of institutional settings and presents 'entry points' for quickly integrating aspects of agrobiodiversity into existing courses (Rudebjer *et al.* 2011). The Guide, along with a range of learning resources, is also available on-line: www.bioversityinternational.org/training/agrobiodiversity_education

Strategies for integrating agrobiodiversity into curricula

Because universities have different educational aims, internal capacity, resources and external environment, a range of strategies can be used for enhancing agrobiodiversity:

1. ***Informal integration into existing courses and programmes***: This approach can be used without formal curriculum review, as part of teachers' continuous improvement and innovation of the courses he or she teaches. Raising teachers awareness of the subject, and improving the access to ready-made teaching materials can support this strategy.
2. ***Add new agrobiodiversity courses during curriculum reviews***: Whenever a curriculum is up for review, this is an opportunity to develop a new course on the subject, preferably a core course that every student will have an opportunity to take.
3. ***Establish new programmes on agrobiodiversity***: Some universities may see an opportunity to offer full-fledged programmes on agrobiodiversity, particularly at post-graduate level.
4. ***Stimulate thesis research on agrobiodiversity***: Many exciting research topics of relevance to current issues including climate change, value chain enhancement of underutilized species, conservation strategies, food and nutrition, etc. These topics often involve multi-disciplinary research, a competence increasingly in demand.

5. ***Short courses on agrobiodiversity for working professionals*** (on-the-job training). Can be organized as part of universities out-reach mandate, and could also be an income-generating activity.

A common feature in the above strategies is that agrobiodiversity could have multiple entry points in curricula. For example, the informal integration of agrobiodiversity in to curricula (strategy 1 above) could take place in a wide range of topics (Table 2).

Table 2: Entry points for introducing agrobiodiversity content in curricula (adapted from Rudebjer *et al.* 2011)

Entry point	Examples of agrobiodiversity content
Adaptation to climate change	Matching crop varieties to new climates Breeding for adaptation to climate variability
Agricultural economics	Value chains for neglected or underutilized species Marketing of speciality foods
Agricultural policy	The International Treaty on Plant Genetic Resources for Food and Agriculture The FAO 'State of the World' reports on plant, animal and forest genetic resources
Agronomy	Farmers' informal seed systems The use of diversity to mitigate risk
Crop science and plant breeding	Genebank management Participatory plant breeding Pre-breeding
Ecosystems conservation	Pollination Payment for environmental services In situ and on farm conservation (e.g., of landraces, non-timber forest products and crop wild relatives)
Ethnobotany	Management and conservation of wild plants The cultural significance of agrobiodiversity
Health and nutrition	Food diversity and food composition Nutrition and traditional foods
Soil and water management	Resilience in agroecosystems Microbial biodiversity

Finally, the integration of agrobiodiversity requires that the lecturers have access to suitable training materials, preferably materials that stimulates 'experiential learning' and the active participation of students. Bioversity and its partners are therefore developing a growing library of learning materials available on-line. Examples of recent materials include:

- The **Crop Genebank Knowledge Base** aims to contribute to more efficient and effective ***ex situ*** conservation of crop genetic resources through facilitating easy access to the knowledge and best practices for genebank management of selected crops and to many aspects of general genebank management http://cropgenebank.sgrp.cgiar.org/
- **Forest Genetic Resources Training Guide** is a set of case studies that supports the teaching and learning of forest genetic resources for non-specialists. It enables teachers and trainers to cover FGR issues in their courses, and increase understanding of how to manage diverse and complex forest and other tree based ecosystems sustainably. http://www.bioversityinternational.org/training/training_materials/forest_genetic_resources.html
- ***In situ*** **Conservation of Crop Wild Relatives (CWR) - eLearning Modules** was developed to help conservationists gain insight into the tools and methods involved in the effective conservation of CWR. The goal of the Modules is to enhance conservation of CWR, and to build the capacity to use this information and raise awareness of the potential of CRW for improving agricultural sustainability. http://www.cropwildrelatives.org/capacity_building/elearning/elearning.html

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EFFECTIVENESS AND RESULTS OF EDUCATION IN THE NATIONAL TRAINING-CENTER OF DUSHANBE

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The organization of education on the conservation of plant genetic resources (PGR) is an important criterion in the establishment of effective structures participating in agrobiodiversity conservation on the national level. These structures should attract the farmers, renters and local communities who have serious problems in the activity due to the lack of special knowledge in the fields of fruit-growing, agronomy, biology, ecology, economics and others to participate in PGR conservation.

Increasing the level of farmers' knowledge these fields allow the successful realization of conservation programmes and more in-depth study of agrobiodiversity. Education is also directed to the close cooperation of farmers with scientists of agronomy who participate actively in project activities. Their joint efforts help to achieve successful results in the project implementation.

Capacity-building in the national training center of Dushanbe had the aim of increasing the level of special knowledge of farmers and local communities as well as researchers and decision makers. For the period under review, education on nine priority crops (apple tree, pear, apricot, peach, grape, sea-buckthorn, mulberry-tree, walnut and pistachio) and was carried out here for audiences from various parts of central, southern and southwestern Tajikistan. The results of this training led to positive practices that demonstrate the effectiveness of the training.

Positive results for researchers came from their regular participation in the training-seminars in the regional center of Tashkent, where assistance is provided in strategic choices of training courses, compilation of educational materials and in other key training areas.

Training events for farmers and local communities successfully achieved their aims according to the opinions of participants and as reflected in questionnaires. Participants in these events expressed great interest in the discussed issues, shared their own experiences with others, and raised many questions during the lessons. In addition, they continue to consult with scientific employees of the center even after training courses were completed, and their interest in increasing their knowledge helps us to define more exactly and choose the most appropriate programmes for educational seminars, as well as to develop, disseminate and demonstrate material in the most accessible formats.

Leaders of forestry institutes in specially protected natural territories often requested the organization of field seminars and consultations with scientific personnel in the training centers. As a result, additional arrangements were made for training courses on multiplication methods for fruit and nuciferous crops, pruning and protection measures in the forest nurseries of Pyandj, Khuroson and Shakhrinav and many other institutes.

A training seminar on the "Conservation of agrobiodiversity of local varieties and wild relatives of fruit, nut species and grape" for members of the Zumrad Children's Ecological Society was very interesting and effective. This four-day field seminar was held in Karatag Gorge, the natural boundary of Labidjay of Shakhrinav District. Twenty-five members of youth clubs took part and many of them were not accompanied by their parents. Two trips/walks with a total distance of 25 km were made, old orchards in abandoned villages with wild and neglected fruit trees including walnut, mulberry-tree, apple-tree, pear, grape and others, many of which exceeded the age of 70-80 years and more, were described. Practical lessons were held in the fields, participants took photos, made sketches, and collected herbarium specimen. Mini-lectures and training in the different ways of grafting fruit crops were held in the camp. Lessons that were held on mountains where many fruit trees of local varieties grow were very interesting for the participants. Answers to many questions yielded good results through the combination of practical lessons and mini-lectures with demonstration using paintings and photos of the best local varieties of fruits, and also achieved the aim of training audience sof teenagers and youth.

Farmer participants in the training demonstrated a very high level of activity in their establishment of farms, cooperatives and associations. They exchanged experiences, made many suggestions for improving legislation and simplifying and perfecting the training process.

At the same time, the seminar participants looked forward with great interest to the marketing research and economic analysis discussed by specialists from the Institute of Agricultural Economics. But in spite of relevance of the theme, perhaps it was difficult for the audience and requires special, accessible demonstration material.

As a whole, the work carried out in the training center of Dushanbe to educate many types of audiences has had a positive result and the accumulation of practice has a positive effect on the conservation of agrobiodiversity of local varieties of fruit crops and their wild relatives even after completion of the project. A basis for sustainable cooperation between scientists engaged in fruit-growing and farmers, and local communities was established and priorities were defined for increasing the transmission of knowledge.

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TRAINING OF RURAL PUPILS ON ENVIRONMENTAL SKILLS

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Of the five priorities of science and technology development that were accepted by the Government of the Republic of Uzbekistan and approved by the State Scientific Technical and Innovative Programmes, four of them, in one way or another, are connected with ecologically sustainable development of the country.

The main ecological problems of the region are: breach of natural ecosystems; lack of qualified drinking water stipulated by degradation of water resources; and reduction of biodiversity (Tashkent 2008).

In order to solve these problems it is necessary to change the stereotype values of modern society, public consciousness and to establish high-level civil activities. It is necessary to make the population aware of their private responsibility for their actions in the environment and to impart knowledge, practical skills, and style of behavior to them for potential successful solutions to ecological problems, particularly during difficult economic and social situations. In this connection, current needs have arisen to increase the level of ecological ethics as a constituent part of general civil behavior.

An effective system of ecological education is one of the tools for ensuring sustainable development (SD) in both economics and society. The principle of SD envisages the conservation and transmission of finite reserves of ecological capital to future generations, including fertile top soil, fresh air, water, climate forecasts, ozone layer and genetic biodiversity (Almaty 2008).

Giving significance to ecological education and enlightenment among both urban and rural youth and helping them to realize the importance of biodiversity conservation in the region, ECO NNA considers it a duty to participate in the application of new relationships to the environment. In 2007-2008 ECO NNA “Zarafshan” carried out a major activity among elder pupils, farmers and communities living near the Zarafshan State Reserve within the framework of the Regional Ecological Center of Central Asia (REC CA) effort called the “Rational use of medicinal plants is the way for improvement of life of farmers communities” and a project of the Programme of Small Grants of the Interstate Commission on Sustainable Development (ICSD) entitled “Receipt of additional sources of income

by farm communities during rational use of medicinal plants is the contribution to sustainable development of the region".

Harm to the natural environment in the region leads to the loss of natural resources, damages human health and leads to the worsening of people's livelihoods. A law on social activity and an insufficient level of ecological awareness aggravate the existing situation. Environmental institutions cannot prevent the loss of natural resources arising from anthropogenic pressures on the environment.

The main social and economic problems in the villages of the project territory (Djambay and Bulungur districts of Samarqand region located near the territory of the Zarafshan State Reserve) have insufficient sources of natural gas, a low level of enlightenment, marked population increase and worsening of health. The total amount of income of families is reduced. In this situation people's influence on the territory of the reserve sharply increases at the expense of damage to the reserve regime (cattle grazing, storage of wood, collection of herbals, fruits and berries, haying, poaching).

Damage to the ecological balance between use of natural resources and their natural revival is observed here as the result of the extensive development of the national economy and the irrational use of natural resources without sufficient accounting of specific aspects of ecosystems.

More than 2580 species of wild plants grow on the territory of Zarafshan valley; among them 218 species of medicinal plants. Ten percent of plants growing in this territory were entered in the "Red Data Book of the Republic." Among them were 143 species (65.4%) that are used in the area of national health care and 75 species (34.6%) are used in scientific medicine. The flora of Zarafshan Reserve consists of 53 species of ether-oil and 50 species of medicinal plants.

Finally, disorderly and exorbitant approaches to the collection of medicinal plants is observed, which causes fatal damage to the biodiversity of flora in the region. For this reason, the work with local communities living near the protected territory of the Reserve is currently directed toward assistance in the sustainable use of biodiversity and in the improvement of the livelihoods of the population. It includes the demonstration and encouragement of the development of alternative types of activities that are nature-friendly (during collection, storage and processing of medicinal plants); education on the rational use of nature and the establishment of mini-plantations for medicinal and underutilized plants.

The aim of the seminars was to increase the level of public awareness and understanding of issues regarding the sustainable development of the country, methods and mechanisms for achievement of sustainable management and use of plant resources growing on the territory contiguous to the Zarafshan Reserve and which also satisfies the economic needs of farm communities. Information about medicinal plants and herbals, the history of their utilization in medicinal and sanitary purposes from the times of Avicenna up to the present, possibilities of cultivation of medicinal plants in the region for creation of alternative sources of income, were all discussed in the seminars (as an example of the Europad project "Conservation of biodiversity of the Western Than-Shan – Phase P" and

the project "Establishment of Nuratau-Kizilkum Biosphere Reservoir as a model for the conservation of the biodiversity of Uzbekistan") (Nukus 2010).

Seminars were held in two stages – theoretical issues on the first day and practical concerns on the second. The practical seminar was held in all villages of the project territories and its aim was to impart practical medical, ecological and economic skills regarding the choice of medicinal plants for cultivation in mini-plantations of home-gardens, to present rural multi-stakeholders with a system of agrotechnical methods of cultivation, collection, processing of medicinal plants for further use and to obtain additional income. The following themes were discussed: choice of the most popular medicinal plants and herbs (rich with mineral substances and vitamins) for cultivation; preparation of seed material and planting on experimental mini-plantations; detailed instructions on agrotechnical methods of growing medicinal plants; information about useful properties of different organs of medicinal plants (leaves, footstalks, roots, etc.); techniques and information on the correct storage of medicinal raw material; information on regional and national organizations engaged in storage of medicinal raw material and their expertise; utilization of visual kits, videotape recordings with information of characteristics of some medicinal plants and herbs and their use in medicine.

Instructive activities on issues of biodiversity conservation in the region were also held within the framework of the project of the Program of Small Grants of the Global Ecological Fund in Uzbekistan (PSG GEF) "Revival of tugai (riparian) forests in the valley of the Zarafshan River – potential for conservation of biodiversity in the region". In the rural schools of Akdarya District, seminars dedicated to the organization of "Clubs of Forest Friends" in these schools and establishment of ecological paths were held. The main aim of these seminars was to convince pupils, teachers of biology, chemistry and geography as well as administrators of the school to the importance of the attendance of students in the process which has been already begun in order to reverse some deforestation of tugai massifs in Akdarya District of Samarkand Region. It is necessary to note that there are different study groups at schools but study groups on forest protection do not exist. At the seminars tutors explained the reasons why restoration of tugai is needed and showed the possible benefits from supporting the tigai ecosystems, both for environment and for the inhabitants. The model on the theme "Friends of the Forest" was prepared for the seminar. It included sub-themes on the necessity of protecting the environment (mini-lecture), on types of voluntary student societies (mini-lecture), school forestry (mini-lecture), how to grow a forest, vegetation of tugai (work with posters), animals of the tugai (work with posters), how to create a school nursery (work with dissemination materials), rules of behavior in the forest (work with posters), on organization of actions and holidays,and biocenosis of tugai forests. In addition, dissemination material as rules with information about some of the plants and animals of the tugai was prepared. A set of posters for seminars was also prepared: 1. Tree is my friend; 2. The rules of behavior in the forest; 3. Animals of tugai firest; 4. Trees, shrubs and herbs of tugai; 5. Biocoenosis of tugai.

A seminar entitled "Birds Day" was held with students as an example of an "Organization of actions and holidays." Student participation in the seminar

showed that they were interested in environmental activities and were eager to take practical action on protection of natural ecosystems in the country.

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INSTRUCTIVE WORK WITH FARMER COMMUNITIES ON CONSERVATION OF AGROBIODIVERSITY IN SAMARKAND REGION

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The Republic of Uzbekistan is a signatory to the Framework Conventions of the United Nations on climate change, on biological diversity and on the fight against desertification. The main factors behind the process of desertification, climate change and reduction of biodiversity are: degradation of lands as a result of anthropogenic activity; mineralization of surface and subsoil waters; irrational use of water resources; and removal of timber and shrub vegetation. (Tashkent 2006).

Uzbekistan has carried out many activities that contribute to the implementation of the Millennium Development Goals, in particular the project entitled “Integration of principles of sustainable development into the politics and program of State and responses to the process of loss of natural resources by 2015” (Tashkent 2008).

In this connection, great importance is given to support to ecological activities in all areas of development carried out by the NGOs in Uzbekistan, including increase of public awareness and encouragement of local communities to recognize the significance of ecological decisions and the strengthening of the country’s commitments to the international conventions.

In the economics of Uzbekistan, the agrarian sector plays an important role. Appoximately 64% of the population live in rural villages and more than 30% of all employees work in this sphere. Thus, due to the expansion of territories for agricultural crops, the territories with natural biocoenoses are considerably reduced in the Republic, resulting in the reduction of biodiversity. One of the main sources of biodiversity in Uzbekistan is forest ecosystems (Asian Development Bank 2006).

Characterized peculiarities of most types of ecosystems of Uzbekistan are their high intolerance connected with arid climate. In this connection the resistibility to the outward interactions is quite law, that’s why any interference by

humanity causes serious factor for degradation of natural ecosystem (Kreyzberg-Mukhina 2005).

It is known that the state of forest genepool has been damaged sharply in the Republic for the last ten years: firstly, about 1500 km^2 of forest lands are taken for the need of agriculture, as the best saxaul plots and specially valuable tugai forests were transmitted for agricultural use; secondly, process of degradation of forests on lands transmitted for long-term use began to develop intensively where exhaustion of vegetation cover, deflation of soil and other negative processes have been occurred. Especially plain inundable timber-shrub ecosystems were suffered, and at present the area is only 250 km^2 which was reduced by ten times (Tashkent 2006).

Recently, issues in the conservation and revival of biodiversity of forests have become high priority. In this connection, in 2009 ECO NNA "Zarafshan" began to implement the arrangements planned by the project that was approved by the Program of Small Grants of the GEF, "Revival of tugai forests in the Zarafshan valley: potential for conservation of biodiversity of the region". The project aimed to restore the tugai forests in the delta of the Zarafshan River of Akdarya District of the Samarqand Region. The implementation of the project was based on the joint efforts of Akdarya Forestry, farmer communities living on territories bordering on the tugai massifs, students, farmers, in farmer communities, representatives of the ecological association "Zarafshan", specialists from the biology faculty of Samarqand State University and representatives of the Samarqand Provincial Committee on Nature Protection.

Within the framework of the project, four preliminary meetings were held with farmer communities in villages located near deforested plots of tugai forest in Akdarya District of the Samarqand Region. Questionnaires were used at the meetings with farmer communities in order to define the level of awareness of the communities of the impact of tugai forests and their relationship to the conservation of this important resource.

The results of questionnaire showed the following:

1. The bulk of the population thinks that in tugai cattle can be grazed, trees/shrubs can be removed for private needs and medicinal plants and herbs can be stored. Only not minority of the respondents (20%) noted the necessity of tugai for clean of air and 10% noted its usefulness for improving the climate.
2. Fully 80.9% of farmer communities do not have accurate information on vegetation in tugai (trees, shrubs) – 80.9%. In this connection, the Asiatic poplar was logged and almost disappeared in the tugai of Akdarya District in the Samarqand Region, Virtually non of the respondents know about this plant.
3. The majority of respondents (53.8%) supposes that tugai forests are in a bad state, 24.4% think they are in a good condition and 21.2% had no opinion.
4. A total of 70% of farmer communities are well aware of the fact that rapid degradation of tugai has occurred as the result of their unsanctioned actions and a huge anthropogenic effect.
5. Anthropogenic pressures by local communities were noted by 53.6% of respondents as caused by the lack of natural gas and irregular supply of electric power. One of the reasons for the threat to tugai forests is the absence of the supply of natural gas, which was noted by 43.8% of the respondents.

6. A huge threat to tugai forests is the removal of trees/shrubs (24.1%) and cattle grazing (24.2%), in the opinion of farmer communities.
7. Farmer communities expressed their wish to receive information on technologies for vegetable-growing (44%), trees (18.9%) and agricultural crops for cattle feeding (25%) on rented plots.
8. From the answers about storage of plants for cattle feeding, it is obvious that there is no information on the use of fast-growing agricultural plants that are successfully used in the practice of cattle-breeding. If inhabitants have cattle (56.3%), sheep (74.2%) and domesticated fowl (93.8%), the application of new methods for livestock management helps to supply additional income for the family that can be directed to purchase of coal in winter.
9. Answers regarding medicinal plants were given by respondents since the tugai of Akdarya District includes such plants as sea-buckthorn, hawthorn and dog-rose. Respondents identified as medicinal plants in use sea-buckthorn (76%), dog-rose (68%), hawthorn (47.3%) and djida (51.3%). However, most of the farmer communities lack detailed information on the properties of these medicinal plants with regard to vitamin and mineral substance content and all of the answers were of a superficial nature.
10. From the questionnaires, it was obvious that farm communities have only a superficial and partial understanding of the need for an urgent and continuous process of conservation and revival of tugai forests. Inhabitants have very poor knowledge of tugai biodiversity in terms of its flora and fauna. In addition, there is no understanding of the need for active work on the restoration of tugai for future generations who will live in the area.

In Akdarya District of Samarqand Region, small plots forest nurseries are planted with seed material that is the basis of tugai forests (sea-buckthorn, hawthorn, dog-rose). Care and protection of the nurseries are supplied by inhabitants of the villages bordering the tugai massifs who signed lease agreements on favorable terms following the regulation entitled “Obligations of protection and care of forests in exchange of gardens or kitchen-gardens.” The agreement allows farm communities to grow either fast-growing species of trees (e.g., poplar) or vegetables, fruits and medicinal raw material for further realization, as well as agricultural crops for cattle feed on rented land.

Based on the questionnaire, demonstrations were held in farm communities in 2009-2010 of good practices and modern technologies for the cultivaton and care of the seedlings that are the basis of tugai forests. Instruction was given on issues relating to the impact of tugai forests on the conservation of biodiversity in the region. Practices in the effective production and storage of feed for farm animals were suggested and information was given on the possibility of cultivating medicinal plants for commercial purposes. The club “Friends of the Tugai Forest” acknowledged revivalist role as the custodian of tugai forests in Akdarya District of the Samarqand Region and established branches in rural schools with the assistance of school administrators and biology teachers (Kreyzberg-Mukhina 2005).

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SPECIES DIVERSITY OF WILD FRUIT SPECIES IN TURKMENISTAN

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Turkmenistan is an ancient agricultural country, the region of the richest plant genetic resources, unique endemic and indigenous species and varieties of wild and cultivated plants with breeding traits and properties. The natural and climatic conditions of Turkmenistan, particularly the piedmont zones of the central and western Kopet Dag, play an important role in economic development in the region. These zones are the repository of the gene pool and diversity of species and forms of fruit crops, subtropical crops, hardy-shrub species and grape.

Within the GEF project "*In situ*/on farm conservation and use of agrobiodiversity (fruit crops and wild fruit species) in Central Asia," supported by UNEP and coordinated by Bioversity International field surveys of the biodiversity of target wild fruit species were conducted in areas of the western and central Kopet Dag, as well as foothills of the Syunt-Khasardag Range (Shikhimdere Gorge). Within the western Kopet Dag, the territory from the Upper Sumbar (the Almaly system of valleys) and the Sayvan zone (the Aydere Valley) to Khodzhakala Valley and the Chendyr zone (near Makhtumkuli Farmers' Association). Birlishik and Germab were surveyed in the central Kopet Dag.

The main purpose of the research was the study of biodiversity of fruit crops – pear, plum, and apricot—and revealing their best forms based on a complex of economically valuable traits. Below is a summary of the results of the survey.

Pear

Pear has been known since ancient times as a fruit crop and now grows in many different areas of the world. It takes second place in terms of distribution, giving way only to apple. It belongs to the *Pyrus* genus of the *Rosaceae* family. The primary center of origin of the genus, according to N.I. Vavilov, is East Asia, where now a large number of its species grows. Secondary centers of pear speciation are Central Asia and the Mediterranean. In total there are about 60 species in the world.

Four pear species grow in the territory of Turkmenistan, two of which are listed in the Red Book of Turkmenistan.

1. *Pyrus boissieriana* Buhse, 1860 – Boissier's pear, Buassenin armydy. It is a rare endangered species, poorly studied to date. It grows on the northern boundary of

the habitat at an altitude of 900-1300 m above sea level on dry fine-grained-rocky slopes with single trees or clumps. It is found in the southwestern Kopet Dag in Khasardag, Chokhagach, Tutly, Hozlydag and Kunzundag Mountains.

Boissier's pear is a small shrub or tree 2.5-4 meters high with an asymmetrical crown. Leaves are glabrate, rounded-ovoid, on long thin stem. The fruits in umbellate corymbs are small (about 1 cm in diameter), round, yellow, with numerous lenticels on the peel, and deciduous calyx. The pulp is dense with a high content of stone cells and sweetish in a ripe state. Pear blossoms in April-May and ripening begins in September-October. The numerous root shoots are a sign of a long-standing adaptation to environmental xerophilous conditions. Boissier's pear is of interest to breeders as a drought-resistant species.

Boissier's pear is partially protected in Syunt-Khasardag Reserve and listed in the "Red Book of Turkmenistan". Saving this endangered species requires measures to strengthen the protection of mountain forests, habitat inventory, monitoring of numbers and special breeding activities in the phytonursery of the Syunt-Khasardag Reserve.

2. *Pyrus turcomanica* Maleev, 1936 –Turkmen pear, Turkmen armydy. This species is endangered and endemic to Kopet Dag. It is distributed in the central Kopet Dag in Archebil, Kurkulab, Sulyukli, Mergenolen, Prokhladniy, Messinyov and Hyrsder, and in the southwestern Kopet Dag – in Ayder, Karagach, Mustafadere, Dalvarli, Tutly, Gyuen and Deyneder. It grows mainly on dry rocky fine-grained slopes of valleys (less often in river valleys) in the middle mountain belt in the form of individual trees.

Turkmen pear is a tree of 10-12 m height with a broad irregular crown. Annual shoots are densely pubescent in spring and bare after that. The leaves are round or oval, 4-7 cm long, 3-5 cm wide and leathery. Young leaves are densely pubescent. Leaves on coppice shoots are rarely lobed during the first year after that they are entire. The fruits are globose or short pear-shaped, 2-4 cm in diameter with a thick stem and a broad flat top where short broadly triangular white tomentose sepals remain. Ripe fruits are yellow or yellow-green, the pulp is rough with stone cells, the taste ranges from bitter and sour to sweet (edible after storing), often with a resinous hint.

It flowers in April-May, fruits ripen in July-August-September. The pear propagates by seeds and shoots. It is a xerophyte but in agriculture its fruits increase in size and become juicier, and some wild pears make a good product after drying. It is reasonable to use these pears in creating forest orchards in the valleys of the Kopet Dag. Seeds can be used in the cultivation of stock material.

The species is listed in the "Red Book of Turkmenistan" and is protected in the Kopet Dag and Syunt-Khasardag Reserves. It is necessary to conduct an inventory of habitats, monitor its populations and introduce it to agriculture.

3. *Pyrus regelii* Rehd: Regel's pear grows in mountainous Bukhara, Upper Zarafshan, in Kugitang in Turkmenistan. It is a typical xerophyte, of polytypic character. It is found occasionally in the middle mountain belt on dry rocky/ crushed stone slopes among the rocks.

It is a tree or a shrub, 2-3.5 m height with numerous spines. Leaves have thin peel, and are bare, light green, usually pinnate and dissected. The flowers are in multiflowered nested corymbs. As well as sepals, the pedicels are tomentose and pubescent. The fruits are round or flat-rounded, 2-3 cm in diameter, yellow-green with a rough bitter-sour tart pulp. Seeds are large, up to 1 cm long and 0.7 cm wide.

It blossoms in May, the ripening starts in September. It is propagated by seeds. This is the most drought-resistant form of pear, hence it is of exceptional value as a stock and as breeding material for crossing.

4. *Pyrus communis* L. – Common pear, armyt. In Turkmenistan, this species grows in the wild in the middle mountain belt (1300-2000 m above sea level) in valleys as individual trees in the southwestern Kopet Dag in Ayder, Dalvarli, and in the central Kopet Dag in Archebil (in agriculture).

The trees of common pear are 10-15 m height, rarely high shrubs. Branches are with or without spines. The leaves are medium-sized (5 cm in length, 3.5 cm wide), thick, rounded or rounded-ovoid, entire. The flowers are in few-flowered umbels. It blossoms in April and ripensing begins in August-September. Fruits are 3-4 cm in diameter, mostly pear-shaped or rounded, green or yellow, sometimes with a reddish erubescence. Under cultivation, the fruits become larger with a juicy and tasty pulp.

Long-term study of the cultivated and local pear varieties and forms revealed such zoned varieties as Bere Zhiffara, Bere Ligelya, Josephina Mekhelnskaya, Lesnaya Krasavitsa, Lyubimitsa Klappa, Podarok and Olivier de Serres. It should be noted that under the influence of high temperatures and dry air, the eating qualities of the fruits may decrease. In Turkmenistan, a favorable microclimate is highly important in the pear orchards. Thus, for example, in Makhtumkul zone the color and taste of the fruit as well as the appearance of the plants improve together with the advance of pear up the Sumbar Valley to an altitude of 800-1000 m above sea level. A favorable combination of light soils, high humidity and tight-knit mountains that protect the trees from dry winds make it possible to obtain high yields with good quality of pear fruit in the upper part of the Sumbar Valley. In Turkmenistan, with careful selection of sites for pear cultivation, and the selection of varieties adapted to local growing conditions, pears to meet the requirements within the country can be grown.

Alycha

Alycha is one of the species of the *Prunus* (plum) genus of the Rosaceae family (*Rosaceae yuss*) *Prunus divaricata* LLb – cherry plum, garaly. The Transcaucasia with adjacent territories of Turkey and Iran are considered the primary center of the alycha crop. Common in Central Asia vare arieties bear the imprint of the east- and north Iranian forms of this plant. In Turkmenistan, in the southwest Kopet Dag, alycha grows in the lower mountain belt at an altitude of 700-1000 m above sea level along the gorges near streams and rivers, in the undergrowth of nut and other deciduous shrubs. Its habitats in the valley of the Sumbar River are located

in Khozly, Yoldere, Ayder, Koynekasyr, Tutlybil Valleys; and Tutly, Kuraty, Gyuen, etc. gorges along the Chandyr River.

Polymorphism of alycha is unusually high. The researcher of wild fruit species of the Kopet Dag, M.G. Popov, marked Turkmen alycha out as a separate variety *P. divaricata turcomanica*. M.Ror, localized in the Kopet Dag.

The life form of alycha is a shrub or a tree, 2-3 (up to 4.5) m in height with more or less spinous or drooping branches. The bark on young shoots is reddish-brown, and it is gray on long-standing branches. The leaves are oval, oval-ovoid, 1.2-5cm long and 0.5-4 cm wide, edges are finely serrate-dentate. Flowers bloom a little earlier than the leaves; petals are white, roundish-oval. The fruits are round or oval, 0.7-1.8 cm in diameter, yellow, light red, pink to dark cherry-red. The kernel is not detachable. In cultivation, alycha fruits are large (10-30 g), with good palatability and a harmonious combination of acid and sugar. The consistence of the pulp is quite dense and juicy. The sugar content in fruits is from 7.2 to 9.4%, acid 0.4 - 1%, pectines 0.7-1.7%, and ascorbic acid 5.8-16.3 mg/100 g. Alycha has high–quality technical qualities. It is used by local populations for cooking preserves, compote, marmalade, jams and jellies.

Alycha blossoms in March-April, and ripens in July-August in the foothills, in September-October in the mountains. In cultivation alycha ripens earlier—in June and July. Alycha begins fruiting in its second or third year, and its yield is regular and abundant. Alycha is a moisture-loving species but some of its ecotypes are extremely drought-resistant.

In contrast to its Caucasian forms, Turkmen alycha produces many root shoots. It is propagated by seeds and root shoots in nature, in cultivation through budding. Alycha is used as a stock for cultivated plum, apricot and peach.

In the valley of the Upper Sumbar a vigourous alycha tree is found, which local people call Uldzhe. Its fruits are large, sweet-sour, and ripen in June. Uldzhe is an excellent rootstock for plum. The best forms were identified from local alycha species, which have been studied in Makhtumkuli SEPC PGR. Those include Karakalinskaya plotnomyasaya, Lyudzha vydelennaya, Lyudzha Turkmenskaya and Turkmenskaya nectarnaya.

In addition to cherry plum, garden plum *Prunus domestica* L., which belongs to the plum genus, also grows in the southwestern Kopet Dag in the wild. It is found as individual trees near mountain streams in the upper Ayder, Karagach, Yoldere and Khozly Valleys, along with walnut, Syrian ash, and other species. The garden plum of the western Kopet Dag is a multiplied root-sucker offspring of feral trees. Each group of wild plums is represented by one from. Fruits are mostly dark blue, more rarely red, yellow or green, of medium and small size. The ability of the Kopet Dag plum of vegetative reproduction is great: in 6-8 years one stem wood creates around itself a grove of 10-12 trees located quite far away from each other (at a distance of 2-3 m).

The main biological characteristic of the Kopet Dag plums, their ability to repeated flowering and self-fruiting, allows the plants to fruit in the most adverse weather conditions. They are of interest for breeding because they do not suffer from gumming.

The cultivation of alycha and plums in Turkmenistan is promising and necessary. The conveyor of fresh fruit supply starts from at the end of May and lasts until November. The number of wild alycha and plum populations is still enough to survive, although they are steadily decreasing.

Apricot

Common apricot *Armeniaca vulgaris* Lam. belongs to the *Rosaceae* family and the plum (*Prunoideae*) subfamily. The Kopet Dag apricots are preserved mainly in the central Kopet Dag (the Khodzhakala Valley) and, more rarely, in the basin of the Sumbar. The Kopet Dag apricots (South Turkmenistan) represent a relic microcenter of primitive apricots of the Iran-Caucasian group preserved by seeds.

Despite the small-fruitedness, the Kopet Dag apricots are characterized by high-quality fruits, many of which have sweet kernels. In this they greatly excel half-cultured apricots from Central Asia (Khasaki).

The Kopet Dag apricots have fruits that are mostly oval or egg-shaped, are only yellow and orange in color, with an average fruit weight of 13 grams (4 to 32 g), with medium and low pulp density. These and other traits of the fruit sharply distinguish the Kopet Dag apricots as a specific (Kopet Dag) subgroup of apricots of the Iran-Caucasian group.

In the Khodzhakala Valley in the small towns of Khodzhakala, Bendesen and Imarat, local apricot trees grow that are, according to local residents, the second generation of apricots that grew here in the past. In the Valleys of Charbag several seedling apricot trees – offshoots from old apricot trees—grow. Trees of local apricot varieties still can be found in the central Kopetdag (Birlishik, Gerbam, etc.). Most of them are sweet-seeded or bitter-seeded, and individual plants are high – up to 10 m.

Trees are averagely leafed. Fruits are medium-sized, often small, of yellow-orange color, the pulp is dense or medium, but not sweet, and of good harmonious palatability. Table and dessert varieties dominate but there are also good fried fruits varieties. The fruits are medium-sized with excellent taste and a sweet stone.

There are trees with racemose type of fruiting, with 30 - 40 fruits located on the branches of 25 - 40 cm length. The productivity of these apricots is high. This type of fruiting can be attributed to the “spurring types” which is fairly rarely met. There are apricot trees with stones bordered by deep funnels. There are no cases of fungal diseases, such as Coryneum blight and shoot wilt.

The study of local apricots of the Kopet Dag showed that this is a collection of primitive cultivated apricots of the Iranian group, preserved by seed. Today, the apricot collection consists mainly of varieties of the Subkhany and Khurmai Central-Asian type.

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WILD GRAPE IN THE GORGES OF THE SOUTHWESTERN KOPET DAG

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Genetic resources of grape in the southwestern Kopetdag are represented by wild forms and cultivated varieties. The thickets of wild grape are preserved in their natural habitat in the Syunt-Khasardag Reserve, the Magtymguly Forest, mountain reserves and unprotected areas. Cultivated local and introduced varieties of grapes are preserved in the collections of the Magtymgul Scientific and Experimental Production Center of Plant Genetic Resources in the vineyards of farms in Magtumguli district and in orchards of the local people (Pashikov 2007, Pashikov 2010).

There are thickets of grape in the valleys of the southwestern Kopet Dag that are quite a heterogeneous population of current wild and feral cultivated grapes as well as their natural hybrids. The best forms are selected from this diversity, which has resulted in the creation of many local varieties. Therefore, a mountainous area of Turkmenistan, particularly the southwestern Kopet Dag, is rich in local ancient grape varieties.

Local people use grapes in almost all the valleys of the southwestern Kopet Dag. In addition, from ancient times the thickets of wild grape have been the source of artificial selection of the best forms, from which outstanding local native varieties have been created by the local populations over the centuries.

The specificity of the variability of wild grape of the western Kopet Dag and the sharp differences between individual thickets and bushes are evidence that the centers of origin have formed naturally. The grape grows where there is water. Thriving, it climbs to the tops of the largest trees in valleys. Wild grape is almost no longer found in pure form. Over 80% of vines grow in mixture with trees and shrubs, which support them. In the valleys the creeping thickets often consist of grape and blackberry, which plays a special role as a good protection against damage by cattle and livestock. The dominant species are karkas, hawthorn and field elm, which co-inhabit with two-thirds of the total grape vines.

As part of the GEF project "*In situ*/on farm conservation and use of agrobiodiversity (horticultural crops and wild fruit species) in Central Asia," supported by UNEP and coordinated by Bioversity International thickets of wild grape in the valleys of the southwestern Kopet Dag were examined and morphological traits were analyzed based on the results of the descriptions. Below we present the results of these analyses.

Shoot: Wild grape has strong leading shoots, and poorly-developed fruit shoots. Green softwood shoots of 90% of the thickets are bare. Tomentose pubescence was observed at the bottom and the top of shoots in 10% of thickets. Coloring of the shoot apex is green in most cases, but sometimes red.

Leaf: Medium-sized leaves dominate, making up 80-90% of the total. The percentage of grape with small and large leaves is 6 and 7%, respectively. Small-leaved forms of grape are found in the Parkhay Valley and medium-leaved in the Yol Dere and Ay Dere Valleys. Large leaves are typical mainly for feral cultivated grape or its seedlings. The leaves can be of rounded and ovate shape. Two-thirds of vines have averagely dissected leaves, one-third only lightly dissected leaves and only very small part has excessively dissected leaves. In terms of pubescence of the leaf, bare (45-50%) and bristle (23%) forms prevail. Pediculate vallecula are almost always closed, arched or lancet. In most cases, the butt is shorter than the central vein and relatively rarely longer. In general, in terms of leaf characteristics, the vines close to the wild forms prevail.

Flower: The study of the sex of wild grape is very important. In August, it is already impossible to distinguish between the vines with functionally female flower type, but male vines are clearly distinguished by the dried inflorescences. In the mountain valleys of the southwestern Kopet Dag there is a very high percentage (40-45%) of vines with a male type of flower. The presence of dioecious plants is a criterion of wild grape habitat of *Vitis vinifera* subsp. *sylvestris* Gmell. type. Usually after flowering, inflorescences with male flower type dry out. Very rarely, pectinates continue to grow on some vines until the end of vegetation, remaining green and ligneous. This mutation of male flower types is the initial stage of intersexuality.

Bunch*:* Medium-sized bunches prevail in grape populations, making up 80%, followed by smaller ones. Large bunches are a rarity and they were observed in feral grape. In terms of density, the bunches are mostly friable and very friable. The bunches of medium density constitute 10-15% of the total number. The number of berries in the bunches ranges from 30 to 130 pieces, but in most cases 30-60 pieces. Grape forms with branched bunches are commonly found, however, plants with cylindrical and cylindrical-conical bunches often grow.

It is interesting to note that the staminal inflorescences are often have very large, thick, green ridges, which are preserved until the fall on bushes, not drying out. Inflorescences of this type are absent in true wild grape.

Berries: In terms of shape and color of berries, the wild grape of the southwestern Kopet Dag is characterized by great diversity. Plants with black berries prevail (60%), white berries are found more rarely (15%). Plants with pink and red berries constitute 25% of the total. In all the valleys the ratio of plants with different berries color is about the same.

The shape of berries is only round and oval. In various valleys there are different forms of grapes with different shapes. Plants with round berries are most common in Parkhay. Thickets with elongated berries are found in the Ayder and the Yolder. In Ayder there are also plants with round-oval berries. The consistency of the pulp is basically juicy, sweet and sour-sweet, so that the forms of wine types prevail.

Seeds: The number of seeds per berry ranges from 0 to 4. Seeds vary in size from 5 to 8 mm in length. In most cases, the size of the seed is 6-7 mm in length with a small beak. The length of the seed beak is short in some cases as in case of typical wild grape, but there are also plants with a long beak. The seed shape is round, in general, with ridges or beveled sides.

The seeds of wild grape of the southwestern Kopet Dag are quite uniform in size and shape, varying within narrow limits.

As a result of the field surveys and descriptions of wild grape of the southwestern Kopet Dag we can conclude that there are forms of true wild grape (*V. sylvestris* Gmell) and feral cultivated grape (*V. sativa* DC). There are also many hybrid types which seem to have developed as a result of natural hybridization of wild (*V. sylvestris* Gmell) and cultivated (*V. sativa* D.C.) grapes. Rich source material for further hybridization and breeding can be obtained during comprehensive study of individual forms of wild grape. Many forms of wild grape are valuable genetic resources for the improvement of cultivated varieties due to their drought and cold resistance. The conservation of these grape genetic resources is important for plant breeders, researchers and local people.

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