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THE STATE OF AGRICULTURAL PLANT GENETIC RESOURCES IN MONTENEGRO

ABSTRACT

Biological diversity is a foundation of human existence and its role in sustainable development is becoming increasingly valuable. Genetic resources in food and agriculture (agrobiodiversity) represent one of the most important components of overall biodiversity.

Rich Montenegrin plant gene pool represents important natural resource for food production and agriculture in general. Intensification of agricultural production, inadequate land usage and human negligence resulted in disappearance of large number of local varieties and population. However, small part of diversity is saved thanks to extensive production of farmers. Although in last few years big efforts were done in order to collect and conserve them, accession number in national gene bank is still small, as a consequence of long delays in organized work on genetic resources.

This paper represents the status of plant genetic resources in Montenegro and the activities carried out in order to preserve them.

Keywords: Montenegro, plant genetic resources, gene bank, conservation

INTRODUCTION

Plant genetic resources are the foundation upon which world food production is based and a key factor in the fight against hunger. Generations of farmers and breeders around the world have left thousands of locally adapted populations, resulting from centuries of natural and mindful selection as a legacy to humanity (Myers, 1994). Plant genetic resources are a reservoir of genetic diversity and a valuable material for creating new cultivars. Increased genetic variability allows a wider range of species and a greater ability to adapt to

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various environmental changes, including new diseases, pests and change in climatic conditions (Hammer and Tekla, 2008). Broad genetic base of populations contributes to increased genetic variability and ecological valence adjustment (Milošević et al, 1996).

The richness and diversity of wildlife is a recognized feature of Montenegro, especially if its small area is considered. In the territory of Montenegro about 3600 species and subspecies of wild vascular plants have been recorded (Stešević and Jovović, 2008). So, according to updated calculation the index of floristic diversity (logS/Log A) of Montenegro is ca. 0.858. In comparison to different regions of tropical, subtropical and temperate zone (Stevanović et al, 1995), this value is rather high, what makes Montenegro one of a biodiversity hotspots of Europe. Montenegro has two World Heritage sites, MAB reservation (Man and Biosphere) and five national parks. Therefore, Conservation International marked Montenegro as one of the four key points of biodiversity in Europe and Central Asia, which significantly increases competitiveness in the global market of eco-tourism (Tankosić Kelly, 2008).

With the disappearance of traditional production systems a huge number of cultivated species, varieties, and locally adapted populations disappeared or are in a brink of survival. For biodiversity preservation is more important to preserve a large number of species than individual genes or genotypes (Dragin et al, 2009). Gene banks are the safest place to keep the varieties that were rejected as commercially uninteresting with the transition to intensive agricultural production. Everything that exists in gene banks today is only a symbolic sample of what really exists in nature, although they often conserve many cultivated varieties that don't exist anywhere else. Preservation of agrobiodiversity is crucial for the survival of the human population and "the best we can do for ourselves and generations to come is to collect this enormous wealth of nature as soon as possible and save from ruin" (Harlan und Martini, 1938). Unfortunately, mainly due to lack of funds, many banks around the world have collapsed, and with them the priceless wealth of genetic diversity.

Genetic erosion control is mainly done in two ways: one is *ex situ* conservation, which is basically their "storage" in gene banks, botanical gardens and experimental research centers (Plucknett et al, 1987), and second, *in situ* conservation, is preservation in the cultivated areas, or natural habitats (Brush 1991, Maxted et al, 1997). The main way of *ex situ* preservation of genetic resources is in gene banks. Over 1750 gene banks exist in the world today with 7.4 million accessions (Second Report on World plant genetic resources for food and agriculture, FAO, 2010). In more than 2,500 botanical gardens around the world large number of extremely valuable *ex situ* collections is preserved. Unfortunately, due to poor documentation (incomplete or completely missing), uncompleted characterization and evaluation, as well as difficult access to these conserved material and data, a significant part of the collections are not used in sufficient volume (Thorne, 2011). In the absence of viable economic systems that would evaluate genetic resources it is hard to provide funds for implementation

of existing programs and normal functioning of the gene banks. Even the minimal actions made towards the conservation of genetic resources are often perceived as consuming activity. Montenegrin gene is faced with same difficulties as well.

RESULTS AND DISCUSSION

The institutional framework for the conservation of genetic resources for food and agriculture

According to the *UN Convention on Biological Diversity* (that Montenegro ratified in June 2006), Montenegro committed to work on two important and challenging tasks in accordance with particular Montenegrin conditions and capabilities:

- First, the development of national strategies, plans or programs for the conservation and sustainable use of biodiversity and
- Second, the integration of conservation and sustainable use of biological diversity into relevant sectoral and above sectoral plans, programs and policies.

As a part of the activities related to implementation of these commitments the Government of Montenegro, adopted the *National Programme for the Conservation of genetic resources in agriculture* (2009 - 2013) in December 2007, and *The action plan and conservation of genetic resources in agriculture* (2009 - 2013) in June 2008, as an instrument for its implementation. Important space to sustainable management of natural resources is also given in the agricultural strategy from 2006 (*Montenegrin agriculture and European Union - A Strategy for food production and rural development*). Work on the implementation of these priorities was further updated by budget, establishing programs for genetic resources (*Support program of conservation and use of genetic resources*) in 2007. All activities are related to the preservation of Montenegrin gene pool and harmonized with *Convention on Biological Diversity* and the *FAO Global Plan of Action*. Furthermore Montenegro was admitted to the Food and Agriculture Organization of the United Nations *(FAO)* in 2008, and as participant in the *European Cooperative Programme for Plant Genetic Resources (ECPGR)* since 2009. *International Treaty on Plant Genetic Resources (ITPGRFA)* was signed in 2010.

Although awareness of the importance of plant genetic resources for food and agriculture is growing, social concern about them is still not satisfactory. Thus there is a reasonable fear that this wealth can be quickly and seriously compromised. Conservation of genetic resources should be observed as a national interest demanding strong state support (primarily from Ministry of Agriculture and Rural Development and Ministry of Sustainable Development and Tourism), and other relevant structures. To prevent further erosion of agrobiodiversity and preserve current condition, it is necessary to include all institutions that in their jurisdiction have the preservation of the environment: universities, research institutions, plant breeders, seedlings producers, farmers, NGOs, etc.

A key role in gathering, collection, and studding of plant genetic resources for food and agriculture has Biotechnical Faculty in Podgorica, while other relevant institutions are involved in the implementation of specific activities: Faculty of Science and Biology-Biology Department, the Republic extension service in plant production, "13. jul Plantaze" AD Podgorica, Montenegro's Natural History Museum, the National Park "Biogradska Gora", and some local NGO-s (the Centre for development of agriculture, Fitofarmakon etc.).

Activities concerning collection and preservation of genetic variability

Collection of indigenous materials in Montenegro started in 1940-es, but it was done exclusively for scientific research and selection purposes. The first organized examination in Montenegro started in 1987 and covered vines, fruits, and wheat. The basis for the beginning of organized collection, preservation, study, exchange and use of plant genetic resources was the *Strategy for the technological development of the country*, adopted 1987 in Yugoslavian Assembly. Due to the lack of a clear program on the conservation and sustainable use of genetic resources, obtained results were far from expected and resulted in a significant loss of collected material (Penčić, 2005a). Two years later, trough the project "*Establishment of the gene pool for the Gene Bank needs of Yugoslavia"*, these activities were resumed again (Penčić, 2005b). Unfortunately, due to the war and the breakup of Yugoslavia activities started on the project were suspended in 1992.

As a result of reasonable fear that part of the collected genetic material can be permanently lost, their custody became a concern of the Agricultural Institute in Podgorica (now Biotechnological Faculty) since 1992. Modest financial support along with some other reasons, has led to losing a significant number of genotypes. Activities at the gathering and study of agrobiodiversity were minimal trough that period of time. However, worth mentioning is that in the period from 2001 to 2006, as a short-term project assignment of Federal Institute for Plant and Genetic Resources, researchers from the Faculty of Agriculture Novi Sad have done several expeditions to collect wild wheat relatives from the *Aegilops* genus and local wheat populations on a number of localities in Montenegro. The aim of this project was to examine genetic base of wild relatives and relationships with cultivated varieties based on cytogenetic and molecular study of the of wild relatives genome (Petrović and Dimitrijević, 2002; Dimitrijević and Petrović, 2004, Dimitrijević et al, 2004).

The situation in this field changes significantly in 2004 when SEEDNet project *(South East European Development Network on Plant Genetic Resources)* implementation begins, financed by the Swedish International Development Agency (Sida). The aim of the project was to intensify and enhance the regional Balkan cooperation in conservation and sustainable use of plant genetic resources through a coordinated network of national programs for plant genetic resources. In the project implementation, 12 countries of Southeast Europe participated. Swedish Biodiversity Centre (CBM) as the executing

agency gave significant support as well as the Nordic Gene Bank (NGB) that was in charge for training and technical support. This support significantly strengthened technical and human capacities related to the collection, preservation and study of plant genetic resources.

SEEDNet project (2004-2011) had a historical mission in the region, contributing to inventorying, conservation, regeneration, characterization, genetic identification, documentation, establishment of databases and strong regional cooperation. Thanks to financial support of the SEEDNet project modern gene bank was founded at the Biotechnical Faculty in Podgorica in 2004. Montenegrin plant gene bank (MGB) has all the equipment necessary for cleaning, drying, and packaging of seeds, determination of moisture, cleanliness and health of seeds and labeling of samples. Additionally it is equipped for long term storage of seeds (-20°C) and active collections storage (4°C). The entire activities (inventory, collection, characterization, conservation, regeneration, evaluation, documentation and exchange of genetic resources) Montenegrin gene bank is performing in accordance with IPGRI procedures and standards. During the SEEDNet project implementation, tissue culture and molecular identification laboratories were established, activities on inventory, morphological characterization, regeneration, genetic identification of indigenous species/varieties were significantly revived, and field fruit species collections were enhanced. Despite to all the activities, number of accessions in the national collection is still small, as a direct consequence of long delays in the organized work on genetic resources.

Implementation SEEDNet project was done through seven working groups: Cereals and Maize, Medicinal and aromatic plants, Vegetables, Fruit crops and Vitis, Industrial crops, Fodder crops and Documentation and Information.

Condition of existing collections

Cereals and Maize

The intensification of agricultural production in Montenegro, as well as in some less developed countries in other parts of the world, led to a noticeable erosion of genetic resources (Brush, 2000). Recognizing the danger of extinction of a large number of local populations and varieties of the genus *Triticum*, after introducing of high yielding Italian, French and Russian selections, academic Ljubo Pavićević began program of their protection already in 1956 (Dubljević, 1997). During more than 20 years of intensive work, a collection of 200 cultivated and wild species of wheat was formed. A significant part of the collection consisted of indigenous populations from Montenegro (113 samples), 47 samples were collected in other areas of the former Yugoslavia, while 40 samples were received from Italy. The whole collected material was placed into 4 groups:

1.*Triticum turgidum* (in this group there are 111 different populations, 80 are indigenous material, while others originate beyond the borders of Montenegro),

2. *Triricum dicoccum* – spelts (27 and 8 indigenous populations collected from Herzegovina)

3.A group of small wheat (6 domestic and 2 from Herzegovina) and

4. Italian wheat (40 samples of known wild and cultivated species of the *Triticum* genus with several subspecies and varieties that are not grown in Montenegro, a collection was obtained from the Instituto Sperimentale per la cerealicoltura from Rome in 1969).

Unfortunately, due to inadequate storage and irregular regeneration, 20 accessions in this valuable collection is irretrievably lost, so the collection remained with 180 samples. The collection was kept at the Institute of Field and Vegetable Crops (now the Center for Field, Vegetable and Forage Crops) until Montenegro gene bank was formed. After many years of recess, activities for inventorying and collecting crops continued in 2008 within SEEDNet project activities. As a partner in a regional project *Collecting local landraces of maize and cereals (wheat, barley, rye, oat, millet and buckwheat) in South Eastern Europe (2009-2010)* Montenegro gene bank has become richer by seven wheat accessions. At the same time 68 local varieties of corn (*Zea mays* L.), 5 of rye (*Secale cereale* L.), 10 of barley (*Hordeum sativum* J.), 5 of oats (Avena sativa L.) and 6 of buckwheat (*Polygonum Fagopyrum* L) were collected. For each accession in this group passport data were made and transferred to the EURISCO database. Seed samples are stored at -20°C in MGB.

Medicinal and Aromatic Plants

Data collected from different sources suggest that the number of medicinal plants in Montenegrin flora is about 700, and that 300 of them is wide-used in traditional and in official medicine as well. Having in mind aromatic plants as well, the overall number of these species would considerably increase. Gathering of indigenous medicinal and aromatic flora is the easiest, the fastest, and the most common way of getting raw materials. Cultivation of these plants, as a subsidiary activity, is present only in small family farms, whereas plantation cultivation still remains undeveloped (Stešević end Jovović, 2008). According to the Ministry of Agriculture and Rural Development the most exploited species in this group include: Sage (*Salvia officinalis*), Juniper (*Juniperus communis*), Curry Plant (*Helichrysum italicum*), Bay Tree or Laurel (*Laurus nobilis*), Bearberry (*Arctostaphylos uva-ursi*), White or False Hellebore (*Veratrum album*), St. John's Wort (*Hypericum perforatum*), Yarrow (*Achillea milefolium*), Autumn Crocus or Meadow Saffron (*Colchicum autumnale*), Linden (*Tilia* sp.), Dog Rose (*Rosa canina*) and Common Hawthorn (*Crataegus monogyna*).

In spite of the extraordinary natural potential, indigenous medicinal and aromatic flora is seriously endangered nowadays. Improper collecting and overexploiting are not the only threats, but also the lack of adequate law

regulations and trade control. The most illustrative example for this would be yellow gentian (*Gentiana lutea*). In 1982 this species was put on the List of Protected Species, but constant and unplanned exploitation led to its complete extinction in the most of known localities. Some other countries in the region are facing similar problems as well (Stešević end Jovović, 2008).

Therefore the need to protect these resources became even bigger. The first activities with this aim has been undertaken in 2008 (SEEDNet project) when the examination of natural populations of six selected priority species was done *(Salvia officinalis, Hypericum perforatum, Origanum vulgare, Gentiana lutea, G. punctata and Satureja montana)* on multiple sites in Montenegro (Lovćen, Orijen, Rumija, Piperi, Ćemovsko polje, Kokoti, Rijeka Crnojevića, Bijelasica, Sinjajevina, Hajla, Visitor, Bogićevica, Velika i Durmitor). The first collection missions were carried out under the regional project "*Genetic structure of Dalmatian sage* (*Salvia officinalis* L.) *populations: A model for a collaborative research on MAP genetic resources (2008-2010)",* when in multiple southern, central and north-western areas of the state, 11 samples of wild Sage populations were collected. For all collected varieties complete passport data were made, morphological and chemical description is in progress as well as DNA characterization. Data on collected material can be found in EURISCO database.

Vegetables

There is no evidence that anyone studied genetic resources of vegetables in Montenegro. The first inventory of the gene pool of vegetables in Montenegro was conducted in 2007 (SEEDNet project). On a number of localities, 13 vegetables species were inventoried and 45 samples respectively: *Brassica oleracea* var. *acephala* - kale (9 accessions), *Brassica oleracea* var. *capitata* - cabbage (1), *Allium cepa* var. *cepa* - onion (3), *Petroselnimu hortense* - parsley (1), *Latuca sativa* - lettuce (4), *Lycopersicum esculentum* - tomato (1), *Solanum melongena* - eggplant (2), *Abelmoschus esculentum* - okra (3), *Phaseolus vulgaris* - beans (11), *Vicia faba* - broad bean (6), *Pisum sativum* - peas (1), *Cucucmis melo* - melon (1) and *Cucurbita pepo* - squash (3 accessions). Due to a very modest cultivation, small amount of seed was collected, thus the amounts necessary for conservation (-20°C) will be provided through regeneration.

Detailed research on local kale continued in 2008 and 2009 through the regional project *Collection, characteration and regeneration of local kale (Brassica oleracea var. acephala) population germplasm from eastern Adriatic cost region for their conservation in gene bank*, which resulted in 12 new accessions. For all 12 samples passport data is done, primary characterization and evaluation of DNA. For the purpose of their conservation multiplication of seeds will be necessary.

Fruit crops and vitis

Montenegrin gene bank includes six very valuable field collection of fruit trees and vitis: olive (*O. auropaea* L.), fig (*F. carica*) and pomegranate (*P.*

granatum) (Center for Subtropical Cultures in Bar), plums (*P. domestica*) and apple (*M. domestica*) (Center for Continental Fruit, medicinal and aromatic plants in Bijelo Polje) and vitis (Experimental field of the Biotechnical Faculty in Podgorica).

Subtropical fruit crops

Center for Subtropical Cultures in Bar since its foundation in 1937 (established as the State experimental station for the Southern cultures that did not stop working even during World War II) is dedicated to research in the field of subtropical fruit crops.

With the aim of studying growth of these species in our climate zone, in the period from 1937 to 1954 the collections of the leading fruit species with great significance for local populations were formed: 72 varieties of figs, 57 species and varieties of citrus, 14 varieties of kaki, 43 varieties and clones of pomegranate etc. (Miranović and Radulović, 1997). Redžić (1954 and 1968) gives a detailed description of 58 varieties of figs (26 twice bearing and 32 once-bearing fruit varieties) which were at that time cultivated in Montenegrin subtropical zone.

Over time, due to various reasons (the return of land, building of vital infrastructure facilities etc.), a significant part of this material is lost. Collection of various indigenous and long time present varieties of pomegranate and fig trees (12 varieties of figs and 21 varieties of pomegranate), was reformed in 2005 as an activity of SEEDNet project. In the fire that occurred 2008 part of the collection was destroyed, but in the next year was fully rehabilitated. Such events have caused new concept of organization, and collection at another location was formed. In the framework of various international projects the molecular determination of figs accession was done.

It is considered that over 2000 varieties of olive (*Olea europea*) exist in the world. Therefore, it is reasonable to assume that today in olive growing countries varieties cultivated were known since ancient times. In the long history of growing olives language evolution modified the original name, which led to the emergence of numerous synonyms and homonyms. Presence of a large number of synonyms and homonyms significantly hinders and complicates the identification and classification of olive cultivars.

In the area of about 300 km long Montenegrin coast, for over 2000 years of growing olives, a relatively big number of varieties has developed, among which the most important include: Zutica, Fran, Lumbardina, Crnjaka, Drobnica, Zinzulaca, Sarulja, Sitnica, Duzica, Lumbardeska, Barkinja, Gloginja and Lopusica. In addition to these recognized varieties, there are also many different individuals within the existing varieties as well as individuals who are completely different. The greatest difficulty in distinguishing genetic material was inability to apply the morphological characterization, as the morphological characteristics of the most important olive are influenced by environmental conditions.

For many decades the lack of interest in cultivation of old varieties of olive resulted in the introduction of foreign varieties of higher yield potential, fruit quality and oil content in the fruit, and their examination in Montenegrin coast conditions: a collection of olive varieties was introduced in Sutomore (1957 and 1967), Podgorica (1974) and Ulcinj (1979-81). Return to testing of the original, indigenous varieties of olives, in the late 1960s is attributed to Dr. Ksenija Miranovic resulting in her doctoral dissertation on the local varieties Zutica in 1974. Further activities on the identification of local olive varieties were done in early 1990's, under the project the *Yugoslavian gene bank*. Then the studies of the olive gene pool and other agricultural crops were almost aborted. These activities continued in 2004 with the start of SEEDNet project realization. The main emphasis is on old olive trees testing (trees older than 1000 years) and clonal selection in the populations of the most common varieties. This research along with morphological characterization included researches on the molecular level (the research was conducted by partner institutions in Italy and Slovenia). The application of modern protocols, and testing of new techniques (RAPD, SSR), confirmed the diversity recognized on morphological level and also pointed on the differences that exist within the varieties (Zutica). This has opened new possibilities for deeper investigations and comparisons with the genetic material in the region and beyond.

Continental fruit species

The first scientific research of continental fruits in Montenegro started in 1953 and was directed in studying the biological, physiological and technological characteristics of the continental varieties of indigenous fruit trees. Shortly after a number of collections were formed: apples (150 varieties), pears (49 varieties), plums (34 varieties), peaches (9 varieties), cherries (23 varieties), sour cherries (15 varieties), apricots (4 varieties), strawberries (19 varieties), black currants (16 varieties), red currants (3 varieties), raspberries (7 cultivars) and blackberries (3 varieties) (Adamić et al, 1963; Jovančević and Čardaklija, 1957). Activities in studding of continental fruit crop genetic resources was again intensified in 1989 within the federal project of the gene pool for the *Yugoslavian gene bank* but, due to the war in former Yugoslavia, were soon interrupted. At that time the inventory and collection of new genotypes of continental fruit crops was done: apples (8 varieties), brandy plums (7 varieties), cherry plums (5 genotypes), pears (7 varieties), wild cherries (4 genotypes) and walnuts (2 genotypes).

All tree collections of continental fruit varieties were destroyed by former owners in 1992 when the *Act on returning farmland to former owners from public property* came into force. On that occasion they destroyed a very valuable collection of indigenous varieties of small fruits, which in this volume did not have any other institution in the former Yugoslavia, as well as the collections of fruit rootstocks and the newly created hybrids of apple and pear (**Krgović, 1997**). This significantly ruined the basis of continental fruit scientific research.

This situation lasted until 2008 when, thanks to regional projects: *Characterization of local apple varieties (Malus domestica) from South East*

European region and the Collection and field evaluation of local plum (Prunus domestica) genetic resources from South East European Network activities intensified again. In 2008, 2009 and 2010, 79 old apple varieties and 44 varieties of old plum genotypes *in situ* (Božović et al, 2010, 2012; Jaćimović and Božović, 2011; Jaćimović et al, 2011) were inventoried on numerous sites. For all inventoried accessions passport data and primary characterization of some important morphological characters is done. Passport data of important apples and plums accessions are also in EURISCO catalog. Efforts made in the implementation of these projects have resulted in the creation of two international monographs: *The Balkan Apple pomology* (described Montenegrin 26 varieties) and *The Plum Balkan pomology* (described 17 Montenegrin varieties).

Field collections (*ex situ*) of apple (60 accessions) and plums (15 accessions) were formed in Bijelo Polje in 2010. Inclusion of other accessions in field collections of plums and apples will be completed later this year and next year.

Vitis

Montenegro has a long tradition of vitis growing. Undoubtedly, the viticulture and winemaking represent one of the oldest population occupations in the central and southern part of Montenegro. This is certainly the main reason for such a great wealth of germplasm in vineyard fields through Montenegro.

Montenegro gene bank has one of the richest collections of domestic, domesticated and introduced vitis varieties in the Balkans (until MGB foundation, this collection was the responsibility of the Centre for Viticulture, Wine and Fruit of the Biotechnical Faculty in Podgorica). This collection is located at the experimental field of the Biotechnical Faculty Lješkopolje, and it's created from an old collection that was built in the period since 1956 until 1960 and has been successively amended to date (Pejović and Mijović, 1997). Old collection had over 500 varieties, but significant number has been lost due to already mentioned problems. During relocation of collections in 2002 408 accessions were determined (Cindrić et al, 2003). In this collection there are 203 old varieties, 20 newly (Maraš and Pejović, 1997) and 185 introduced vitis varieties. Proper documentation of every variety is kept. So far characterization and primary evaluation of all varieties was performed to the 21 feature codes according to OIV. For hundred accessions the passport data is made that can be found in EURISCO web catalog (European catalog search, with passport data for plant genetic resources that are stored *ex situ*).

Besides this, the Montenegrin gene bank posses an extremely valuable collection of population of variety Kratošija. This collection consists of 17 varieties - biotypes of Kratošija variety (kratošija velja, kratošija mala, kratošija, kratošija srednja, crni krstač, ljutica, vrančina, vran, vranac, vrančić, kratošija sa dubokim urezima, velji vranac, srednji vranac, vran, bikača, cestozglavica, rehuljača) collected from different viticulture areas of Montenegro, which

indicates its centuries long cultivation in this region (Ulićević 1966, Pejović, 1988; Maraš, 2000).

Viticulture and winemaking sector of Montenegro is based on the cultivation of indigenous vitis varieties and wine from these varieties. Given the importance of vitis gene pool for the vineyards and winemaking sector considerable efforts were made towards its preservation. Through numerous national and international projects identification of indigenous and other domesticated varieties and studding of populations' variability is done. After genetic identification of important Montenegrin indigenous varieties (vranac, kratošija, krstač, žižak), and identification of Kratošija as zinfandel (primitive) very close genetic relationships (parent-offspring) was determined between varieties Vranac and Kratošija (Callo et al, 2008).

In the period from 2008 until 2010 in the SEEDNet regional sub-project (*Identification, characterization and conservation of old indigenous vine varieties in Eastern European countries*) at 8 sites in central and southern part of the state 15 accessions were marked *in situ* (interesting vine-stocks within the heterogeneous population of indigenous varieties). For all of them the characterization on the 21 character codes of OIV is made and the taken material was sent to Croatia (Zagreb Faculty of Agriculture) for DNA identification.

The implementation of the SEERA project (*Preservation and establishment of true-to-type and virus free material of endangered grapevine cultivars in Croatia and Montenegro*), aims to perform ampelographic description and genetic identification with SSR analysis for 20 selected biotypes of neglected vitis varieties and produce virus free planting material that will be collected. During this year part of virus free material produced will be collected and will serve for further multiplication. The project will end in late 2012.

As country rich in vitis germplasm, which can be very important for global biodiversity and its conservation, Montenegro has recognized the need to preserve indigenous Montenegrin vitis varieties, developing research methods for the identification and characterization of genetic resources and methods for the mobilization of genetic diversity through sharing experiences, information and materials with other researchers from Eastern and Western Europe. There is no doubt that Montenegro will, trough collaboration with other researchers from Europe and its involvement in the COST action in 2012 (*East-West collaboration for grapevine diversity exploration and mobilization of adaptive traits for breeding*), make a significant contribution to genetic diversity and the mobilization of adaptive traits for breeding and sustainable use of neglected vitis varieties.

Industrial Crops

Potato was brought in Montenegro more than 200 years ago. Continuous growing in very different agro-ecological regions and mikroregions - from the sea coast to the mountains, potato differentiated trough time in early, mid and late characters (forms). Early forms were grown in coastal areas and river valleys

of the Adriatic basin, medium early on hills and mountains up to 600 to 700 meters of altitude and late forms in the mountain area. In the research conducted in 1950-ties in the area of Old Montenegro, 8 local potato varieties were inventoried: pitomi or ruski krompir, rani bijeli, rani zuti, bijeli kasni, zuti kasni, italijanski, naski krompir and svabica (Pavićević, 1991).

Due to intensification of agricultural production in Montenegro significant number of old potato varieties was lost, which led to serious erosion of genetic variability. Nowadays traditional cultivars and domesticated varieties are generally grown in small households in distant rural areas. Predominantly these varieties are grown by older people. Very good organoleptic properties and cooking, and in some case sentimentality are accentuated as reasons for their cultivation. Growing of old potato varieties is often a consequence of their specific characteristics (resistance to disease, low and high temperature, drought, etc.), poor financial conditions and lack of planting material (large distance from the city). Today old potato varieties are grown only in traditional production systems, mainly for domestic consumption, while only a small number of them can be found at local markets.

Except the inventory done by academic Ljubo Pavicević in the middle of the last century, there was no organized preservation of the potato gene pool in this region until 2008. Activities on the conservation of germplasm of this very important culture re-started with SEEDNet project-*Research, collection and characterization of local forms of industrial plants*. During the implementation of this project 52 potato accessions were collected. Description and evaluation of genetic material was carried out on the field, according to FAO (IPGRI) standards and sufficient number of potato populations was collected. For all collected accessions passport data was done (according to multi-crop passport descriptors), and after registration in a national database, transferred into EURISCO data base.

Collected tubers were stored in a cold room at 4ºC. Regeneration of potato accessions is done every year in Podgorica (experimental field of the Biotechnological faculty), and on one more location outside of Podgorica.

In 2010 and 2011 in field gene bank located in the municipality Danilovgrad (25 km away from Podgorica), primary characterization of all potato accessions conserved in the National gene bank was carried out. In order to identify duplicates and find unique genotypes, DNA evaluation was performed for 8 most valuable potato accessions in Agricultural Institute in Ljubljana in 2011. DNA testing of the remaining genotypes will be done this year in the laboratory for DNA analysis in Bar (MGB - Unit of Bar).

To ensure and preserve the existing gene pool from potential diseases and pests, potato is maintained in vitro in Montenegrin gene bank (the unit is located in the Centre for Subtropical Cultures in Bar) since 2011.

In addition to potatoes, in this group of cultures there are also two **tobacco** accessions in Montenegrin gene bank.

Fodder crops

The beginnings of fodder crops gene pool studies are related to SEEDNet project in 2007. That year, as a result of activities at the national level, the seeds from 7 local populations of alfalfa (*Medicago sativa*) were collected. In 2009 and 2010 within regional sub-project SEEDNet *Regional collecting expedition and ex situ conservation of Trifolium pratense, Festuca pratensis, Dactylis glomerata and Medicago falcata* 23 wild populations of red clover (*Trifolium pratense*) and 11 populations of cocksfoot (*Dactylis glomerata*) were inventoried and enough seed for conservation (5000-7000) was collected. For all types of collected species complete passport data are made.

Documentation and Information

Today, not much is known about the samples stored in gene banks, and even less or nothing about their usage value. Lack of knowledge about the stored material is a very serious problem and the main reason why breeders so rarely address to gene banks for deposited plant material. The richness of biodiversity is not clear if there isn't a good system for documenting the data and its accessibility and visibility for a wide range of potential users.

As an effort to unify the data and their effective maintaining, updating and availability to interested users, a Working Group on documentation and information was formed. Primary it was planned that the Montenegrin gene bank accepts SESTO documentation system that is used in all the Nordic countries. Although training for documentation and information for countries working group managers involved in SEEDNet project was organized in Sweden in 2007, the establishment of SESTO systems for South Eastern Europe never materialized due to certain unforeseen circumstances. For these reasons, the Montenegrin gene bank keeps the records on all collected accessions in its own database and its design will be defined in the future. In addition to this database, basic passport data of 230 accessions from Montenegro are also available on the website of SEEDNet project (http://www.seednet.nu). The Montenegrin gene pool data will be available on the website of the Montenegrin gene bank (http://genebank.btf.ac.me) which design is in progress.

After signing the Memorandum of Understanding with ECPGR in 2009, the passport data of Montenegrin accessions, systematized by a single descriptor (multi-crop passport descriptors) are available as well on the EURISCO web page (http://eurisco.ecpgr.org). All data on conserved material are systematized by the codes adopted at the working groups level (vines - 1, cereal - 2, vegetables - 3, fogger crops- 4, industrial plants - 5, fruit trees – 6 and medical and aromatic plants - 7). Currently this database contains data on 340 accessions from Montenegro, grouped in 17 genera.

GRIN - global is a new opportunity for greater accessions visibility deposited in MGB. GRIN – global is a new international database established with agreement between the European and North American partners. This new system will provide global information on all the important global plant genetic

resources (www.genesys-pgr.org). Its advantage is a relatively easy access and the possibility of multifunctional filling of database (the user has the ability to deliver data in a form and manner that best suited him). Although this database is still evolving, there are available data on 567 accessions from Montenegro. Some of them have been long held in American gene banks.

CONCLUSION

The intensification of agricultural production and inadequate land use are the most import threats to conservation and agrobiodiversity in general. Indigenous, locally adapted populations are the most vulnerable form of plant genetic resources. Due to habitat destruction and introduction of elite germplasm they are at risk of extinction (Brush, 1995). With the progress of science and selection, in short period of time new high-yield and quality varieties significantly suppressed the indigenous populations on huge surfaces. High genetic yield potential characterizes most modern varieties and thereby is one of the most important criteria when selecting varieties (Heisey and Brennan, 1991).

Biological diversity is the foundation of human existence and its importance in sustainable development and reduction of hunger will increase with time. Therefore it is very important to work constantly in strengthening the awareness of the importance of biodiversity and its impact on the welfare of the human population. In recent years, the genetic resources in the world gained more attention. It seems that the awarnese that preservation of life on earth depends on the conservation of biodiversity has finally rised (Penčić, 2006). Agricultural land represents 38% of the total planet land surface. That's why farmers around the world have a great responsibility in protecting biodiversity. Increased diversity of cultivated crops ensures greater security of food production. The importance of genetic resources for food and agriculture is invaluable from the feeding aspect of daily increasing population, and with time it will gain more on its importance.

The wealth deposited in gene banks has economic significance only if used properly. In order to be useful, samples need to be well preserved, processed (with as much information about useage-value as possible) and properly documented. MGB will ensure that existing germplasm is available to all institutions and individuals (national and foreign) who express interest for it. In addition, it enables its use in research projects at the Biotechnical Faculty, and for international cooperation needs.

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STANJE GENETIČKIH RESURSA POLJOPRIVREDNOG BILJA U CRNOJ GORI

SAŽETAK

Biološki diverzitet je osnova ljudskog postojanja i njegova uloga u održivom razvoju svakim danom postaje sve značajnija. Genetički resursi za hranu i poljoprivredu (agrobiodiverzitet) predstavljaju jednu od najznačajnijih komponenti ukupnog biodiverziteta.

Bogat biljni genofond Crne Gore predstavlja prirodni resurs od velikog značaja za proizvodnju hrane i poljoprivredu uopšte. Intenzifikacija poljoprivredne proizvodnje i neadekvatno korišćenje zemljišta, sa jedne i čovjekova nebriga, sa druge strane, doveli su do nestanka ogromnog broja lokalnih sorti i populacija. Međutim, samo mali dio, zahvaljujući ekstenzivnoj proizvodnji poljoprivrednih domaćinstava, uspješno je sačuvan i spašen od nestajanja. Iako su zadnjih godina učinjeni značajni napori na njihovom kolekcionisanju i konzervaciji broj aksešena u nacionalnoj banci biljnih gena je još uvijek mali, što je direktna posljedica dugogodišnjeg zaostajanja u organizovanom radu na genetičkim resursima.

U ovom radu dat je prikaz stanja biljnih genetičkih resursa u Crnoj Gori i aktivnosti koje se sprovode u cilju njihovog očuvanja.

Ključne riječi: Crna Gora, biljni genetički resursi, banka biljnih gena, konzervacija