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PLANT GENETIC RESOURCES OF SERBIA - SITUATION AND PERSPECTIVES

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Abstract

The paper presents plant genetic resources of Serbia. Old autochthonous varieties including cereals and corn, fodder plants, industrial plants, vegetables, medicinal plants, fruits and vine plants were analyzed. The collections of the Plant Gene Bank of Serbia are presented, as well as the collections that are kept in certain scientific institutions. It was proposed to create a new National Program for the conservation and sustainable use of plant genetic resources and re-entry in the National variety List of certain varieties that have been unjustifiably deleted. The need for further work on collecting and inventorying old and autochthonous varieties was pointed out, especially those that can still be found on farms (*on farm*) with some agricultural producers, and which have not yet been recorded. A proposal of measures and activities for further improvement of the work of the Plant Gene Bank and the overall conservation and sustainable use of plant genetic resources is also given.

Key words: Plant genetic resources, Old autochthonous varieties, Medicinal plants, protection, Serbia.

Introduction

Serbia accepted The First Global Action Plan for the conservation and sustainable use of plant genetic resources for food and agriculture, as well as the Leipzig Declaration adopted during the 1996. Session, which was organized by the Food and Agriculture Organization of the United Nations (FAO) through the genetic resources commission for food and agriculture. Serbia also had joined its implementation.

The Second Report on the state of plant genetic resources for food and agriculture in the world at the FAO level (http://www.fao.org/3/i1500e/i1500e00.htm) was adopted in 2009. Serbia submitted its national report for its preparation, and also committed itself to actively implement the Second Global Action Plan adopted by the FAO Council in November 2011. The preparation of the Third Report with the deadline of December 2020 is in progress.

Serbia has been actively participating in the European Cooperative Program for Plant Genetic Crop Resources (https://www.ecpgr.cgiar.org/) since its establishment in 1979. The work takes place through 23 working groups (20 crop groups and 3 thematic groups). An integral part of this organization is the European search catalog EURISCO for plant genetic resources for food and agriculture in Europe.

The regional project entitled "South East Europe Plant Genetic Resources Development Network" (SEEDNet) 2004-2009 funded by the Swedish government and supported by the Nordic Gene Bank NordGen (https://www.nordgen.org/en/) was launched in 2004. and Serbia actively participated. Within this project, 6 working groups were formed, at the regional and national level, for medicinal plants, vegetables, fruits, vine plants, industrial plants, fodder plants, cereals and corn (www.seednet.geminova.net). The results of this project are the connection of breeders and gene banks in the region, the reorganization and equipping of national gene banks and the creation of a National Work Program for the conservation of these resources.

The FAO TCP project 2010-2011 for technical support project assisted in the final equipping of the laboratory and the drafting of the National Work Program in this area.

Plant genetic resources are maintained by storage: *In situ* (storage at the place where they were found), *on farm* (on the farms of individual farmers, ie agricultural research institutions) and *ex situ* (storage of components of biological diversity outside their natural habitats) such as: gene banks, *In vivo* collections (botanical gardens, etc.), *In vitro* (conservation of vegetative material of fruits and vines), storage of pollen in pollen banks or storage of DNA samples in DNA banks.

In situ , *on farm* and *ex situ* forms are represented in Serbia (especially important Bank of Plant genes of Serbia).

Material and Methods

The paper first describes the Ecological parameters that determines the state of plant genetic resources in Serbia: the position of the state, nature, climate and the socio-economic situation related to this topic. All published research data related to plant genetic resources in Serbia were collected and analyzed.

The data of the relevant Ministry of Agriculture related to the variety lists of existing and deleted registered plant varieties were analyzed. The survey method was used to collect data from the Plant Gene Bank of Serbia about the number of collection and their state, as well as from the Fruit Institute of Čačak, Radmilovac Experimental Estate of the Faculty of Agriculture in Belgrade, Sremski Karlovci Experimental Estate in Novi Sad, and the Institute of Vine plants in Niš.

The work of the Plant Gene Bank of Serbia and its collection were especially analyzed.

In order to visually understand the state of genetic resources in Serbia, tables and graphs have been made by groups that are discussed, and the tables show the most current data.

Results and Discussion

Serbia has a specific geographical position on the line of collision between Central Europe and the Mediterranean, turbulent geotectonic dynamics, diversity of physical and geographical features have made it an area of great genetic, special (species) and ecosystem diversity. There are two units in the relief of Serbia - lowland, Pannonian lowland and hilly, mountainous region (Fig. 1). The southern rim of the Pannonian Basin includes alluvial plains and river terraces along the Danube and Tisa rivers, Loes plato 100 to 400 m high (Banat, Loes platoes Titel, Telečka and Srem) and hilly mountain heights - Fruška Gora and Vršački breg Vršac mountain. The mountainous area of Serbia is very complex and consists of five units: Rhodopes, Carpathians, Balkans, Dinaric and Skardopind mass (Stevanović *et al*., 1995, Myers, 2000). The northern part of Serbia-Vojvodina is flat, belongs to the Pannonian Basin, with a continental semi-arid climate. Central Serbia has a temperate continental climate. In the western part of the country, the average annual rainfall is 720-900 mm, in the mountains 1500 mm; and in the southeast 650–700 mm, in the mountains 1000 mm. Average annual temperatures vary between 9.5–11.7°C in the lowlands (0.5–5°C in the mountains). The coldest month is January with an average between -0.6°C in the mountains and 0°C in the lowlands, while the warmest July is with an average of 11-22°C in the lowlands and 11-16°C in the mountains.

The natural vegetation of Serbia consists primarily of moderately continental forests dominated by numerous species of beech (Fagus), oak (Quercus) and several species of conifers (Pinaceae). Serbia's forest cover is 29.1% (Banković *et al*., 2009).

According to the data listed in the Biodiversity Strategy of the Republic of Serbia for the period 2011-2018 (Official Gazette of RS, No. 13/11), Serbia is characterized by great, not only genetic and species, but also ecosystem diversity. The high mountains and mountainous area of the Republic of Serbia is one of the 6 centers of European biodiversity and one of 153 world centers. Serbia is one of the global centers of plant diversity in terms of the richness of flora. Although with 88,361 km^2 Serbia makes up only 2.1% of the land area of the whole of Europe, the biodiversity of different groups of living organisms is high. In Serbia there are: 39% of the vascular flora of Europe or 3,662 taxa (Stevanović *et al*., 1995).

The following biomes are also found in Serbia:
• Steppe zonobiome,
• Zonobiome of deciduous forests,
• Zonobiome of coniferous forests and
• Zonobiome of high mountain tundra.

The Mediterranean area is one of 34 centers of biodiversity in the world (Myers *et al*., 2000). The Mediterranean region has about 13 000 endemic plant species (10% of the world's floristic endemism) and 235 endemic vertebrates (2.4% of the world's vertebrate endemism). The part of the Mediterranean area belongs to the part of Serbia, primarily the Shar - Mountains and Prokletije, as a high mountain rim of the Mediterranean climate.

According to data for 2018, the number of inhabitants in Serbia was 6,982,604, and the average age is 43.2 years. Over 700,000 agricultural farms are registered in Serbia, and it is estimated that 44% of the total population lives in rural areas, of which 33% are engaged in agricultural activities (Statistical Yearbook for 2019).

Plant genetic resources: Our ancestors had used and collected plant genetic resources over 10,000 years ago. They started by growing and producing certain plant species for various purposes, which led to the domestication of all agricultural species that we use today. About 7,000 to 10,000 different plant species have been cultivated, of which cultivated plants make up 3-4% of the total plant biodiversity. There are about 250,000 species of higher plants in the world, and plants for food and agriculture are among the most important plant species. They make up about 37% of all higher plants (Hammer, 1995).

Plant genetic resources means the total number of genes in the forms in which the species exist, ie. all populations, varieties, cultivars, clones and lines, formed by natural or scientific selection. Species are forms in which the entire genetic potential of living beings is hidden. Genetic variability within a species allows for its flexibility to environmental conditions as well as its ability to survive and adapt to climate change.

Plant genetic resources are important for human and animal nutrition and also provide raw materials for industry. Plant genetic resources are important because they are resistant to low / high temperatures, plant diseases and pests. Resistance that is present in old varieties, populations and wild relatives are of vital importance for the further development of plant production, cereals, industrial plants, vegetables, fruits, vines, etc.

In Serbia the National Program for the Conservation of plant genetic resources for the period 2013-2020 has been adopted and the Law on Management of Plant Genetic Resources is being prepared. Currently, this area is regulated by several existing laws. The Rulebook on Incentives for the Preservation of plant genetic resources (Official Gazette of the Republic of Serbia No. 85/13, 44/18) prescribes in more detail the types of incentives for the conservation of plant genetic resources and the conditions for exercising the right to incentives and maximum amounts of incentives per user and type of incentive.

In *In situ* conditions, there are mostly wild species of medicinal plants, followed by fodder plants. On the farm, many old autochthonous plant varieties are grown and kept on individual households (various old varieties of fruit, vines, tobacco, corn, wheat, etc.). Plants, which are not collected, are in big danger that they extinct. There are also significant collections on agricultural goods of professional and scientific institutions such as collections of fruits and vines on the estates of agricultural faculties in Belgrade and Novi Sad, institutes in Niš and Čačak, institutes for field and vegetable growing in Novi Sad and Smederevska Palanka, Institute for fodder herbs in Kruševac, the Institute for Medicinal Herbs "Dr Josif Pančić" in Belgrade and others. *Ex situ* protection has several forms *(In vivo, In vitro*, etc.), but it is certainly the most important Plant Gene Gene Bank of Serbia.

Fig. 1. Map of Serbia with the geographical position of Serbia in Europe (http://www.maps-of-europe.net/maps/maps-of-serbia/detailed-physical-map-of-serbia-with-all-roads-cities-and-airports.jpg).

Plant gene Bank of Serbia (BBG): The decision to form the Plant Gene Bank was made in 1987, when Serbia was part of the state of Yugoslavia. Firstly, was collected the gene pool, and the construction of the gene bank began. Base collections of most cultivated plant species were formed. The construction of the Plant Gene Bank took more than two decades. In 1989, there was a project "Formation of a gene pool for the needs of the Plant Gene Bank of Yugoslavia", and in 1990. The construction of the Plant Gene Bank complex in Zemun was completed. In the period from 1999-2015, samples of the National Collection were kept at the Maize Institute "Zemun Polje". The Government of Republic of Serbia established the Bank of Plant genes of Serbia (BBG) with the Food Safety Act ("Official Gazette of RS No. 41/09"), ie all activities that existed until then, and now officially placed it under the auspices of the now independent state of Serbia. In the period 2010-2013, a National Program draft was prepared and additional equipment was procured during the FAO technical support project, with the establishment in 2011 of the FAO WIEWS National Information Exchange Mechanism. The following year, in 2012, seed laboratory equipment was procured and in 2013 the FAO International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) was ratified (http://www.fao.org/plant-treaty/ en /). The seed drying chamber was built in 2014, and in 2015 samples of the National Collection from the Maize Institute "Zemun Polje" were transferred to the cold chamber of the Plant Gene Bank and in 2016 a database was formed and regeneration of the most endangered samples began, and in 2017 final draft of the Law on Plant Genetic Resources Management was prepared. In the same year, samples from the Kragujevac Small Grain Center were taken into storage. Modern rooms with laboratories, air chambers and all equipment were prepared. Conditions were created for scientific research and access in the production, collection, use and conservation of plant resources.

There are about 25,000 samples in *Ex situ* collections in Serbia. The Plant Gene Bank is a safe place for storing plant genetic resources for food and agriculture of the Republic of Serbia. The Plant Gene Bank of Serbia implements a complex system of conservation of plant genetic resources for food and agriculture, as well as their collection, classification, characterization, evaluation, documentation and exchange. Participants in the National Program are breeding institutes and centers, but also faculties and other scientific and educational institutions. As in the world's gene banks, corn, cereals, industrial plants, fodder plants, vegetable plants, and medicinal plants are stored in Serbia. Fruit species and vine plants are kept on the experimental properties of the agricultural faculties of Belgrade and Novi Sad and the Center for Viticulture and Enology in Nis. The Plant Gene Bank had 4,300 samples for 249 plant species in 2009. Now, a total of 138 plant species are preserved, ie 46 plant species: cereals, industrial plants, fodder plants and vegetables, and 92 species of medicinal and aromatic plants. The total number of all these species in the period from 2010 to 2015 was 4,051 and in the period from 2016 to 2020 the number was 4,841 (Plant Gene Bank in Belgrade, 2020).

According to Mladenović-Drinić & Savić-Ivanov (2017), 193 species of plants are used for food and commercial agricultural production in Serbia. They are designated as mandate types divided into the following groups:

- Cereals - 12 types
- Industrial plants - 19 species
- Fodder plants of 43 species,
- Vegetables of 71 types,
- Fruits and vines of 48 species

In Southeast Europe, within the "Southeast European Development Network for Plant Genetic Resources" (SEEDNet), plant genetic resources for food and agriculture are grouped into 6 groups:

1. Cereals and corn plants
2. Fodder plants
3. Vegetables
4. Industrial plants
5. Medicinal and aromatic plants
6. Fruits and vine plants.

Over 420 species of medicinal plants are officially registered in Serbia. The exact number in Serbia is not known because there is no BGR National Inventory. It is estimated there exist about 25,000 samples of varieties, old and local populations of cultivated plants in the form of seeds and about 3,500 samples of fruits and vines and they are stored in *ex situ* collections. There are about 20 collections in Serbia housed in the National Bank of Plant genes and institutes. Over 2,000 indigenous and local populations are grown in the fields of individual producers, and part of them is kept in *ex situ*. Many populations of forage plants and wild relatives are found in both: *In situ* and on *farm* conditions (Mladenović-Drinić & Savić-Ivanov, 2017).

Small grains and corn: Wheat (*Tritucum* spp.*)* and corn (*Zea mays*) play a significant role in agricultural production in Serbia.

According to the data (https://publikacije.stat.gov.rs/ G2020/Pdf/G20201019.pdf) for 2019, wheat was sown on 5,577, 499 ha, and the realized yield was 2,535,000 tons, while corn was planted on 962,083 ha, and the realized yield was 7,501,361 tons. Serbia is a significant exporter of wheat and wheat products, as well as of corn and corn products.

In the 1960s, Serbia developed numerous breeding programs for cultivated plants, and from there, it had numerous old autochthonous but also improved varieties of wheat and corn.

The Department for the Protection of Varieties of Agricultural Plants of the Ministry of Agriculture, Forestry and Water Management had compiled lists of several varieties (register of recognized and register of temporarily recognized varieties), as well as the Guide for Recognition of Varieties (http://www.sorte.minpolj.gov.rs/sadrzajd/registar-priznatih-sorti).

In Serbia, there are several dozen farmers who maintain populations of old indigenous varieties of grain and corn on their farms, which are registered in Serbia. There is a significant number of farmers who do this, but they are not registered. In recent years, many private companies and individuals have become interested in these genetic resources and their cultivation.

According to the data for 2005, about 10,200 grain samples were stored in *ex situ* collections in Serbia, and wheat was the most represented. The largest collection is in the Institute of Field and Vegetable Crops in Novi Sad. The largest collections of maize are kept in the Maize Institute (5 806) and NBBG (2 184), (Prodanović *et al*., 2009) (Table 1).

From the (Table 2), it can be seen that the number of samples in the National Collection has not changed significantly after year 2005, except the number of corn samples which are increased. In the period from 2010 to 2015, this number was higher by 45, ie the total number of samples stored in the National Collection was 3,028. In the period from 2016 until today, the number of stored samples is 3,778, but there exists a significant number of samples in preparation (500 preparatory samples of soft wheat, 200 for barley and 50 for corn). It can be concluded that more activities should have been done in the period of 11 years and that urgent measures and actions are needed to collect certain old autochthonous varieties that can still be found on farm with individual producers in Serbia.

Fodder plants: Serbia is one of the largest centers of origin and divergence of a large number of autochthonous genetic resources of fodder plants. Most of these plant species have wild relatives in nature that show a high degree of genetic variability and specificity. The family *Fabaceae* includes quite important fodder plants in the Serbian flora, is represented by 34 genera, among which the most interesting genus is *Trifolium* with 50 species, *Vicia* 27 species, *Medicago* 11 species, *Lotus* with 4 species. Another important family *Poaceae* has 70 genera, of which 17 of *Pao* are very interesting, then *Pheleum* with 8 species, *Festuca* with 21, *Lolium* with 5, *Agrostis* with 6, *Dactylis* with 3 and *Bromus* with 14 species (Tomić *et al*., 2009). These plant species are the main components of natural ecosystems of pastures and meadows. Meadows and pastures are spread over large areas in Serbia, mainly at high altitudes and mountains.

Part of the material, which is kept in the National Collection, as stated by Tomić *et al*., (2009), was created by selection:

- 41 varieties of fodder perennial legumes
- 16 forage species
- 1 park variety of perennial grasses and
- 21 varieties of annual fodder legumes

In the National Collection of the Plant Gene Bank, there are 283 samples of perennial fodder plants. The collection consists of 159 samples of perennial legumes and 124 samples of perennial grasses. It can be seen that 71 samples belong to alfalfa, which is the most important fodder plant in Serbia, and which is grown on large areas having good quality of soil. Other leguminous plants, white and red clover, have become more widespread in recent times, that is, their number has increased significantly. The number of perennial grasses are also increased, primarily with seed samples of domestic varieties. The number of perennial legumes is shown in (Tables 3, 4).

Table 1. Number of ex situ samples of small grains and corn in Serbia in 2005 (Prodanović *et al*., 2009).

Rights holder	Resource type	Wheat *Triticum* spp.	Barley *Hordeum vulgare*	Oats *Avena sativa*	Rye *Secale cereale*	Corn *Zea mays*
Institutes	Local populations	150	80	20	10	2 500
Institutes	Relatives	120	50	15	5	0
Gen bank	Populations	439	117	180	18	2 184
Total	**5 888**	**709**	**247**	**215**	**33**	**4 684**

Table 2. Samples in the National Collection of Serbia for 2005 and periods 2010-2015, 2015-2020 (Plant Gene Bank Department, MPŠV, 2020).

Species name	Label	Number of samples	
Year		2005	2010-2015	2016-2020
Soft wheat (*Triticum aestivum* L.)	YUGB.001	323	323	323+500*
Oat (*Avena sativa* L.)	YUGB.002	180	180	180
Rye (*Secale cereale* L.)	YUGB.003	18	18	18
Barley (*Hordeum vulgare* L.)	YUGB.004	117	117	117 + 200*
Corn (*Zea mays* L.)	YUGB.005	2184	2229	2229 + 50*
Hard wheat (*Triculum durum* Desf.*)*	YUGB.067	116	116	116
Millet (*Panicum mileacium* L.)	YUGB.006	15	15	15
Great Millet (*Sorghum bicolor* L.)	YUGB.007	30	30	30

* Samples in preparation

Table 3. Number of perennial legumes in Serbia for the period 2007-2020 (Plant Gene Bank Department, MPŠV, 2020).

Species		*Medicago sativa*	*Trifolium pratense*	*Trifolium repens*	*Trifolium hybridum*	*Trifolium montanum*	*Lotus corniculatus*
		Number of sample					
Year	2007	71	24	53	6	4	1
	2010	71	24	53	6	4	1
	2015	71	24	53	6	4	1
	2016	70	27	50	6	4	1
	2020	70	27	50	6	4	1

Table 4. Number of samples of perennial grasses in Serbia in the period 2007-2020 (Plant Gene Bank Department, MPŠV, 2020).

Species		*Agrostis stolonifera*	*Agrostis gigantea*	*Agrostis capillaris*	*Agrostis perenne*	*Lolium multiflorum*	*Lolium glomerata*	*Festuca arundinacea*	*Festuca pratensis*	*Festua rubra*	*Festuca pratense*
		Number of sample									
Year	2007	34	15	35	10	4	12	5	3	2	4
	2010	34	15	35	-	4	-	5	3	2	-
	2015	34	15	35	-	4	-	5	3	2	-
	2016	34	15	35	-	4	-	5	3	2	-
	2020	34	15	35	-	4	-	5	3	2	-

It is important to note that most of these samples are included in the breeding process at the Institute for Fodder Plants in Kruševac and the Institute for Vegetables and Farming in Novi Sad in order to obtain new varieties of fodder plants that are more profitable and better adapted to local agro-ecological conditions in Serbia. For most of these samples, characterization and evaluation for the most important traits (phenological, morphological and agronomic) have been done so far for the purpose of breeding.

Industrial plants: Industrial plants are all those plants whose stems, fruits, leaves, roots or any other part, can be used in the processing industry as a raw material. They are usually used in the textile, pharmaceutical and food industries. The group of these plants includes: oilseeds (*Helianthus annuus, Brassica spp., Papaver somniferum, Sesamum indicum, Ricinus comunnis*), plants for fiber yarn (*Linum usitatissimum, Cannabis sativa, Gosypium* spp.), plants from which sugar, starch and alcohol *(Beta vulgaris, Cichorium intybus, Solanum tuberosum,* etc.) are produced, then tobacco (*Nicotiana tabacum*) and *hops* (*lupulus*) (Gadžo *et al*., 2011).

In Serbia, the cultivation of industrial plants makes a little more than 15% of the total arable land, and the most grown are: sunflower, soybean, oilseed rape, sugar beet, potatoes and tobacco. The production of industrial plants is a significant economic activity.

Regarding the realized production of industrial crops for the period 2018, they are shown in (Table 5).

Industrial plants in BBG Serbia: The total number of samples of industrial crops in the National gene bank in Serbia for the periods 2010-2015 and 2016-2020 is shown in (Table 6).

Table 5. Realized yields of industrial crops in 2018-taken from the Statistical Yearbook of the Republic of Serbia, (2019).

Industrial culture	Production, u thousands t (2018)
Sunflower (*Helianthus annuus*)	734
Tobacco (*Nicotiana tabacum*)	7
Turnip (*Beta vulgaris*)	2 325
Potatto (*Solanum tuberosum*)	488

Table 6. Number of samples of industrial crops in the National Gene Bank in Serbia for the periods 2010-2015 and 2016-2020 (Plant Gene Bank department, MPŠV, 2020).

Serial number	Plant species	Number of samples 2010-2015	Number of samples 2016-2020
1.	*Sorghum bicolor* (L.) *Moe* (Sorgnum)	30	30
2.	*Capsicum annuum* L. (Paprika)	57	57
3.	*Helianthus annuus* L. (Sunflower)	91	75
4.	*Helianthus* sp. (Wild sunflower)	78	40
5..	*Ricinus communis* L. (Castor oil plant)	69	69
6.	*Glycine max* (L.) *Merr.* (Soybean)	21	21
7.	*Beta vulgaris* L. (Sugar beet)	60	43
8.	*Linum usitatissimum* (Linen)	16	16
9.	*Cannabis sativa* (Hemp)	31	31
10.	*Nicotiana tabacum* (Tobacco)	-	7*

In addition to the Plant Gene Bank, the Institute of Field and Vegetable Crops from Novi Sad has a significant collection of varieties of industrial plants, and many old indigenous varieties and local populations are grown on farms in Serbia.

As stated in the National Program for Conservation and Sustainable Use of Plant Genetic Resources for Food and Agriculture (2013-2020), the final draft of the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia, only old indigenous and local tobacco varieties in Serbia are grown on farm. Their recording and collecting is now necessary in order to protect them from their disappearance forever.

Vegetables: The area of Serbia is very rich in types of vegetables. Thus, Lazić *et al*., (2013) talking about organic vegetable production, show 9 families of vegetable plants and individual plant species from another 7 families, which makes over 70 types of vegetables.

The national variety list of the Republic of Serbia currently includes 46 types of vegetables (www.sorte.minpolj.gov.rs).

It is believed that today about 1,500 types of vegetables are known in the world, of which about 150 species are grown, while 30-50 species are in wider use (Lazić *et al*., 2017), so the number of types of vegetables that are represented in Serbia of not only national, but also of world importance.

Active collections of vegetable crops are located at the Institute of Field and Vegetable Crops in Novi Sad (1,188 samples of 21 vegetable species), then the Institute of Vegetable Crops in Smederevska Palanka (1,739 samples of 22 vegetable species) (Zdravković *et al*., 2009).

Lazić *et al*., (2017) state that during the harmonization of the situation in the domestic regulations with international regulations, in 2011, a decision was made to delete 251 local populations belonging 54 species or subspecies of vegetables from the variety list (http://www. sorte.minpolj. gov.rs/sadrzajd/registar-brisanih-sorti). As many as 22 species after deleting varieties from 2011 no longer exist on the list of registered varieties. 17 populations of onions have been deleted (most varieties of this onion are on the European list of free varieties).

In the National Collection of the Plant Gene Bank in Belgrade, data for the period 2010 to 2020 were processed (Table 7).

Figure 2 showed that the number of samples did not change in 10 years, it was even constant for all the listed types of vegetables in the National Collection. Only the number of samples increased for beans by 21 (number of samples in preparation). From the above, it is clear that there is a need to collect old indigenous varieties, especially those that were removed from the National Variety List in 2011, but also their return to the National Variety List, because they are grown in Serbia and are on the European list.

Medicinal herbs (LAB): Medicinal herbs are a group of medicinal, spicy and aromatic, wild or cultivated plant species. According to the definition of the World Health Organization (WHO), medicinal plants are those plant species, whose one or more parts contain biologically active substances that can be used for therapeutic purposes or for chemical-pharmaceutical synthesis. According to this, aromatic plants are those, that contain active substances with a special smell (taste) that are used to make fragrances, cosmetics, alcoholic beverages and non-alcoholic beverages and aromas for food products. These species also serve as a raw material for obtaining essential oils (Table 8).

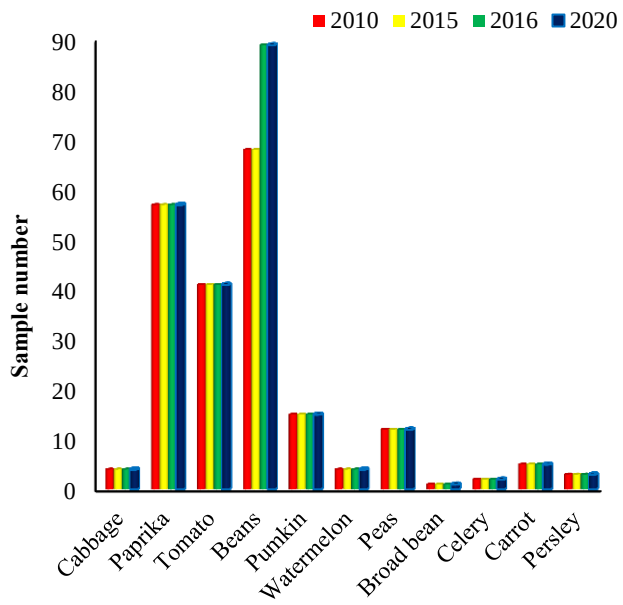

Fig. 2. Number of vegetable samples in the National Collection for the period 2010-2020.

Serbia has a great floristic wealth and there are 3,562 taxons of vascular flora in its territory. It is considered one of the centers of diversity of medicinal plants that occur in meadow, pasture and forest ecosystems, as well as within rare endemic communities of specific biotopes. The diversity of flora included 3,562 taxons of vascular flora, 390 subspecies and vegetation over 1,200 described plant communities (Tomović, 2007). These include the resources of the LAB, which number is over 700 species, which is 19.65% of the total flora in Serbia. About 420 species of medicinal plants or 11.8% of the total flora of Serbia have been officially registered. There are about 279 species of medicinal and aromatic herbs in the market. All in all, Serbia is one of the most important centers of medicinal herbs (Amidžić *et al*., 1999; Panjković *et al*., 2000).

Placing on the market and use of medicinal plants from nature is regulated by the Decree on placing under control the use and trade of wild flora and fauna (Official Gazette of RS, No. 31/05, 45/05, 22/07, 38/08, 9/09, 69/11). This Decree defines the species (63 species of medicinal plants) and the quantities that can be collected from nature, and the quantities are proposed by the Institute for Nature Conservation of Serbia while the permit is issued for collection and marketing by the Ministry of Environmental Protection of Serbia.

Table 7. Number of vegetable samples in the National Collection for the period 2010-2020 (Plant Gene Bank Department, MPŠV, 2020).

Species		*Brassica oleracea* var. *capitata* Cabbage	*Capsicum annuum* Paprika	*Solanum lycopersicum* Tomato	*Phaseolus vulgaris* Beans	*Cucurbita* spp. *Pumpkin*	*Citrullus lanatus Watermelon*	*Pisum sativum Peas*	*Vicia faba* Broad bean	*Apium graveolens* Celery	*Daucus carota* subsp. *sativus Carrot*	*Petroselinum crispum* Persley
		Number of samples										
Year	2010	4	57	41	68	15	4	12	1	2	5	3
	2015	4	57	41	68	15	4	12	1	2	5	3
	2016	4	57	41	68+21*	15	4	12	1	2	5	3
	2020	4	57	41	68+21*	15	4	12	1	2	5	3

* Samples in preparation

Table 8. Spicy, medicinal and aromatic herbs (93) of the plant species, with a total of 120 samples (Plant Gene Bank Department, MPŠV, 2020).

Sr. No.	Plant species	No of samples 2010-2020	Sr. No.	Plant species	No of samples 2010-2020
1.	*Atropa belladonna*	1	47.	*Gentiana kochiana* Perr.et Song	1
2.	*Hipericum perforatum* L.	3	48.	*Gentiana crispate* (Vis.) Holub.	1
3.	*Hipericum hirsutum* L.	1	49.	*Gentianella albanica*	1
4.	*Gentiana utriculosa* L.	2	50.	*Gentianella bulgarica* (Velen.) Holub.	1
5.	*Gentiana ascepiadea* L.	1	51.	*Geum bulgaricum* Panč.	1
6.	*Gentiana cruciata* L.	2	52.	*Geum rivale* L.	1
7.	*Gentiana praecox* (a.et J. Kern) Dost	1	53.	*Geum montanum* L.	1
8.	*Gentiana dinarica* Beck.	3	54.	*Ranunculus thora* L.	1
9.	*Heracleum spgondylium* L.	1	55.	*Pancicia serbica* Vis.	1
10.	*Angelica sylvestris* L.	1	56.	*Wulfenia blecic*	1
11.	*Seseli rigidum* W.et K.	1	57.	*Aquileia vulgaris* L.	1
12.	*Libanotis montana* Cr.	1	58.	*Tanacetum larvatum* Gris.	2
13.	*Rinanthus minor* L.	1	59.	*Dryas ostopetala* L.	1
14.	*Tanacetum corymbosum* (L) Sch. Bip.	1	60.	*Anthyllis vulneraria* L.	1
15.	*Telecia speciosa* (Schreb.) Baumg	1	61.	*Anthemis carpatica* Willd	1
16.	*Solidago virgaurea L.*	2	62.	*Doronicum columnae* Tenn.	1
17.	*Eupatorium cannabium* L.	1	63.	*Geum coccineum* Sibth.et Sm	1
18.	*Prenanthes purpurea* L.	1	64.	*Hypericum atomarium* Boiss.	1
19.	*Centaurea derventata* Vis. Et. Panč.	1	65.	*Anemone narcissiflora* L.	1
20.	*Clematis vitalba* L.	1	66.	*Marrubium peregrinum* L.	1
21.	*Trollius europaeus* L.	1	67.	*Phlomis fructicosa*	1
22.	*Helleborus odorus* Waldst. Et Kit.	1	68.	*Gentiana lutea* L.	2
23.	*Paris quadrifolia* L.	1	69.	*Plantago lanceolata* L.	1
24.	*Colchicum autumnale* L.	2	70.	*Echinacea purpurea* Moensch	1
25.	*Allium ursinatum* L.	1	71.	*Coriandrum sativum* L.	1
26.	*Chamaenerion angustifolium* (L.Scop.)	1	72.	*Pimpinella anisum* L.	1
27.	*Valeriana officinalis* L	1	73.	*Calendula officinalis* L.	2
28.	*Filipendula ulmaria* (L.) Maxim	1	75.	*Sinapis alba* L.	1
29.	*Sorbus aucuparia* L.	1	76.	*Salvia sclarea* L.	1
30.	*Urtica dioica* L.	1	77.	*Leonurus cardiaca* L.	1
31.	*Primula veris* Huds	1	78.	*Melissa officinalis* L.	1
32.	*Rhamnus fallax* Boiss	1	79.	*Hyssopus officinali* L.	1
33.	*Luzula luzuloides* (Lam.) Dandy et Wilmott	1	80.	*Lavandula angustifolia* Mill.	1
34.	*Leuchanthemum atratum* (JACQ) DC	1	81.	*Origanum heracleoticum* L.	1
35.	*Achillea abrotanoides* Vis.	1	82.	*Origanum vulgare* L.Thymus vulgaris L.	1
36.	*Inula ensifolia* L.	1	83.	*Ocimum basilicum* L.	19
37.	*Hypericum barbatum* Jacq.	1	84.	*Althaea officinalis* L.	1
38.	*Leserpitium siler* L.	1	85.	*Oenothera biennis* L.	1
39.	*Gypsophila paniculata* L.	1	86.	*Fagopyrum aesculentum* Moesch.	1
40.	*Anacamptis pyramidales* (L.) Rich.	1	87.	*Cynara scolymus* L.	1
41.	*Paeonia decorata* Anders.	1	88.	*Silybum marianum* (L.) Gaerth.	1
42.	*Paeonia tenuifolia* Anders.	1	89.	*Chamomilla recutita* (L.) Rauschert	1
43.	*Iris reichenbachii* Heuff.	1	90.	*Trigonella foenum graecum* L.	1
44.	*Gentiana pneumonantha* L.	1	91.	*Petroselinum crispum* (Mill.) Nym.	1
45.	*Fagus silvatica* L.	1	92.	*Foeniculum vulgare* Mill.	1
46.	*Gentiana punctata* L.	1	93.	*Matricaria recutita* L. (Kamilica)	40
	Total number of samples				**120**

In situ protection of LAB takes place in the habitat where these plant species are found and developed. In Serbia, 481 natural assets are protected, and these include protected areas classified into 7 species, namely: strict nature reserve, special nature reserve, national park, nature monument, protected habitat, landscape of exceptional features and nature Park. The total area of protected goods is 7.48% of the territory of Serbia (http://www.zzps.rs/). According to the Ordinance on the proclamation and protection of strictly protected and protected wild species of plants, animals and fungi (Official Gazette of the RS, No. 5/10, 47/11, 32/16, 98/16), 2643 wild species are protected, of which there are 641 strictly protected plant species and 570 protected plants. Some of the plants protected by this Ordinance belong to medicinal plants such as lincura (*Gentiana lutea*), sage (*Salvia officinalis*) and their collection from nature is prohibited.

The following institutions deal with *ex situ* protection of medicinal plants in Serbia:

1. Institute for the Study of Medicinal Herbs "Dr Josif Pančić" Belgrade
2. Institute of Field and Vegetable Crops in Novi Sad

One part of the resources is in the living collections of the Botanical Garden "Jevremovac" of the Faculty of Biology in Belgrade, at the Faculty of Pharmacy in Belgrade, the Faculty of Agriculture in Belgrade and the Arboretum of the Faculty of Forestry in Belgrade.

In Serbia, a lot of medicinal plants are grown on plantations, which significantly reduces the pressure on natural resources and increases the quantities and ensures uniform quality of raw materials. According to Turudija-Živanović (2015), up to 5,000 ha of medicinal plants were grown in Serbia in some years. However, the potentials are up to 15,000 ha, and that volume of production would not lead to a surplus. Mandić *et al*., (2019), published a list of 107 species of medicinal plants for which the cultivation technology has been mastered in Serbia, although some 30 species are most often cultivated.

Fruit: Mratinić & Kojić (1998) state that it can be reliably claimed that in the spontaneous flora of Serbia there are ancestors of varieties of pears, apples, plums, cherries, sour cherries, some varieties of almonds, walnuts, hazelnuts, chestnuts, raspberries, gooseberries, red currants and strawberries.

Keserović *et al*., (2017) stated that Serbia was rich in autochthonous fruit varieties, so they listed about 15 varieties of apples, 9 varieties of pears, 2 autochthonous varieties of quince (Leskovačka and Vranjska) that are known at the European level. Serbia is also a well-known producer of plums at the world level (among the first in the world), and the domestic species *Prunus cerasifera* (džanarika) is especially important for its numerous diverse populations throughout Serbia, as well as a dozen other autochthonous plum varieties. Serbia is also known for its autochthonous varieties of apricots, peaches, cherries (Oblačinska višnja) and cherries. There are also large and diverse populations of dogwood (*Cornus mas*), walnut (*Juglans regia*) and hazel (*Corylus avellana*). Of all berry species, wild species are widely used in Serbia: raspberry (*Rubus ideus*) - although Serbia is a world-famous grower and exporter of raspberries, but it is allochthonous varieties, wild blackberries (*Rubus fruticosus*) and wild strawberry (*Fragaria vesca*) and forest blueberry (*Vaccinium myrtillus*) which are annually collected from nature on average of about 1,000 tons (Mandić *et al*., 2019).

Fruit collections are used for pomological characterization, vegetative propagation and breeding.

As stated by Keserović *et al*., (2017) autochthonous and domesticated varieties of different fruit species are of exceptional importance for integral and organic production, but also as a starting material in hybridization for the creation of new, higher quality varieties resistant to diseases and pests.

Genetic material of fruit species is stored *ex situ* for multiple purposes, and a smaller part *In situ* and *on farm*. The farm's way of preserving genetic fruit resources is to preserve plant species on individual farms, farms and gardens. *Ex situ* collections preserve genetic divergence outside natural areas. These are: gene banks, botanical gardens, collection plantations, parks, *In vitro* storage, cryopreservation and DNA banks of genes that are not represented in Serbia. *In situ* protection and conservation is the maintenance of natural populations in their natural range where they evolve without human influence.

Most collections are kept by:

- Faculty of Agriculture, Department of Fruit Growing and Viticulture in Novi Sad
- Faculty of Agriculture, Department of Fruit Growing and Viticulture in Belgrade
- Institute of Fruit Growing in Čačak.

Data for 2020 for the collection Radmilovac - Experimental field of the Faculty of Agriculture in Belgrade and the state of the collection of fruit varieties is shown in (Table 9).

The Collection of the Radmilovac Experimental Field, Faculty of Agriculture in Belgrade keeps 610 genotypes from 11 different fruit species.

Data for 2020 for the collection Sremski Karlovci – Experimental Field Novi Sad and the condition of the collection of fruit varieties are shown in (Table 10).

The Collection of Sremski Karlovci, a demonstration property of the Faculty of Agriculture in Novi Sad, contains 217 genotypes of 11 different types of fruit.

Data for 2020 for the collection Čačak - Institute of Fruit Growing and the state of the collection of fruit varieties is shown in (Table 11).

The Collection of the Institute of Fruit Growing in Čačak preserves 773 genotypes from a total of 7 fruit species. The largest number of genotypes of fruit species is kept in the Collection at the Institute of Fruit Growing in Čačak.

Preservation of autochthonous and old fruit varieties is extremely important due to its pronounced richness in Serbia, ie due to the preservation of overall biodiversity, climate changes that are increasingly pronounced, i.e. due to the preservation of genes that are carriers of resistance to pathogens and pests in given climatic conditions.

Vine plants: (The Radmilovac collection within the Experimental Field of the Faculty of Agriculture in Belgrade in 2020, Collection in Sremski Karlovci within the Experimental Field of the Faculty of Agriculture in Novi Sad in 2020, Collection of the experimental property of the Institute of Viticulture and Enology from Niš, 2020) (Table 12).

Table 9. Collection Radmilovac within the Experimental Field of the Faculty of Agriculture in Belgrade 2020 - data obtained from the Experimental Estate Radmilovac.

Collection plant	Number of genotypes	Surface area (ha)
Indigenous varieties of apples (*Malus domestica)*	64	0,30
Commercial varieties of apples *(Malus domestica)*	30	0,50
Varieties of apricots *(Prunus armeniaca)*	98	1,1
Peach and nectarine varieties *(Prunus persica)*	70	0,50
Grape peach genotypes *(Prunus persica)*	82	0,30
Cherry vareties *(Prunus avium)*	49	0,50
Sour cherry vareties *(Prunus cerasus)*	18	0,30
Types of Cloud cherry (*Prunus cerasus)*	48	0,30
Plum varieties *(Prunus domestica)*	71	1
Varieties of walnuts *(Juglans regia)*	44	1
Varieties of almonds *(Prunus dulcis)*	18	0,25
Varieties of raspberries, blackberries and currants *(Rubus idaeus, Rubus fruticosus, Ribes rubrum)*	18	0,20

Table 10. Collection in Sremski Karlovci within the Experimental Field of the Faculty of Agriculture in Novi Sad in 2020 - data ob tained from the Experimental Estate Sremski Karlovci.

Art	No of genotypes	No of trees
Turkey cherry (*Prunus mahaleb*)	2	3
Sour cherry (*Prunus cerasus*)	60	156
Cherry (*Prunus avium*)	22	94
Dwarf cherry (*Prunus fruticosa*)	17	30
Džanarika, red plum (*Prunus cerasifera*)	6	22
Domestic plum (*Prunus domestica*)	39	95
Blackthorn (*Prunus spinosa*)	2	5
Apricot(*Prunus armeniaca*)	10	100
Peach (*Prunus persica*)	5	15
Pear (*Pyrus communis*)	27	59
Apple (*Malus x domestica*)	27	257

Table 11. Collection of fruit species at the Institute of Fruit Growing in Čačak in 2020 - data obtained from the Institute of Fruit Growing Čačak.

Fruit art	No of genotypes
Apple (*Malus x domestica*)	366
Pear (*Pyrus communis*)	91
Plum (*Prunus domestica*)	155
Apricot (*Prunus armeniaca*)	46
Peach (*Prunus persica*)	35
Cherry (*Prunus avium*)	51
Sour cherry (*Prunus cerasus*)	29

Table 12. Overview of grapevine collections and conditions (*Ex situ, In vivo*) in Serbia from 1996-2020.

Code	Life collections				
	Location	Number of genotypes 1996/ha/number of trees	Number of genotypes 2002/ha/number of trees	No of genotypes 2007/ha/num. of trees	No of genotypes 2020/ ha /number of trees
YUG 01 (SRB 01)	*Radmilovac	376 / 1,27ha	500 / 2ha	659	300 / 1ha
YUG 02 (SRB 02)	**Sremski Karlovci	402 / 1.35 ha / 3.435	471 / 2ha /6 224	737	484 /4 840 trees
YUG 04 (SRB 03)	***Niš	-	-	336 /2 ha	108 / 8 ha
UKUPNO				**1732**	**892**

*Experimental field of Radmilovac
** Experimental field of Sremski Karlovci
*** Experimental field of Nis

It can be concluded that Serbia is very rich in the gene pool of the genus *Vitis*. In three collections, in 2007, 1,732 samples of genotypes were kept, of which 941 were different, and the rest were repeated. There are passport data for samples, characterization and evaluation have been performed. The old collections are recorded in the European database and the new ones were created by multiplying these old samples and supplementing them. The number of genotypes stored today (2020) in the experimental fields of Radmilovac, Sremski Karlovci and Nis is a total of 892 in all three collections.

Conclusions

Serbia is rich in old, autochthonous, but also selected plant varieties, ie plant genetic resources. Plant genetic resources in Serbia are found in *In situ* conditions, *on farm* and *ex situ.* As in the world's gene banks, the following plants: corn, cereals, industrial, fodder, vegetable and medicinal plants are stored in the Plant Gene Bank in Serbia. A total of 138 plant species are now preserved, ei 46 plant species: cereals, industrial, fodder plants and vegetables and 92 species of medicinal and

aromatic plants with a total of 4 841 samples. Collections of fruit species are kept on the following experimental fields: 610 genotypes of 11 different fruit species are kept at the Faculty of Agriculture in Belgrade; The Faculty of Agriculture in Novi Sad keeps 217 genotypes of 11 different fruit species and the Institute of Fruit Growing in Čačak keeps 773 genotypes from a total of 7 fruit species.

Collections of grapevine species are kept on the experimental fields at three institutions: on the Faculty of Agriculture in Belgrade, on the Faculty of Agriculture in Novi Sad and in the Center for Viticulture and Enology in Nis, and at all these three institutions is located total number of 892 genotypes. In addition to the mentioned faculties and the Plant Gene Bank, in Serbia there are more collections of plant genetic resources on ten other institutes that deal with the study of certain plant agricultural species. Many wild species of medicinal plants, fodder plants and fruits are relatives of cultivated species and the preservation of their genetic material is very important. On the farms of individual farms and farms of professional and scientific institutions, many old autochthonous varieties are also kept, which should be collected and preserved before they disappear.

The protection, preservation and conservation of indigenous old plant varieties and their wild relatives is also an obligation under the International Strategy Global Partnership for Plant Conservation (2018) Cape Town, South Africa. Work on the establishment of the Plant Gene Bank began in 1987 (within the former Yugoslavia), so that the Plant Gene Bank as a Serbian institution was officially established in 2009, and from 2015, plant genetic material was transferred to it and put into function.

Serbia has been actively involved in the implementation of the FAO Global Action Plan (regularly submits national reports on the state of plant genetic resources), as well as with EURISCO with which it exchanges the necessary data on its plant genetic resources, and is particularly active in working and thematic group of the European Cooperative Program for Plant Genetic Crop Resources (ECP / GR). Thanks to the SEEDNet and FAO TCP projects, staff training was carried out and the laboratories of the Plant Gene Bank were fully equipped.

In the coming period it is necessary

- to make a new Strategy and Action Plan for the conservation, use and application of plant genetic resources, given that the existing one expires in 2020,
- to prepare the Third national report on the state of plant genetic resources for food and agriculture in Serbia by the end of 2020,
- further work on the collection and inventory of old indigenous plant varieties, the material of which can be found on the farms of individual farms and in nature, in order to preserve this valuable genetic material for future use (varieties of tobacco and other industrial plants, wild vegetables, medicinal plants, fodder plants, etc.), as well as to revise the variety list of deleted plant varieties of the Ministry of Agriculture from which in 2011, by a decision on deletion, removed from the national list as many as 251 local populations from 54 botanical species or subspecies of vegetables from the variety list port -*Allium cepa*, many of which are still grown in Serbia, etc.),
- further develop the capacities of the existing gene bank and perform its permanent equipping (material, personnel and financial strengthening),
- conduct permanent scientific-professional training and strengthening of the professional staff of the Plant Gene Bank of Serbia,
- to develop and maintain permanent international cooperation with competent institutions and organizations, professional institutions of the countries of the region in the exchange of information and genetic material.

Great diversity of plant genetic resources, their cultivation (cereals, corn, fodder plants, industrial plants - sunflower, tobacco, etc., over 70 varieties of vegetables, plantations of medicinal plants and collection from nature, fruit plantations and numerous vineyards), has economic benefits for Serbia. There are some of their products, which are proof of the exceptional ecological, agricultural and economic importance. The potential of genetic resources of Serbia is great and must be taken care of them, with more scientific, institutional and economic attention

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