Scientific Papers. Series B, Horticulture. Vol. LXVIII, No. 1, 2024
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

SMALL HOLDINGS IN MOUNTAIN AND SEMI-MOUNTAIN AREAS IN BULGARIA AND THEIR IMPACT ON AGROBIODIVERSITY

Nikolaya VELCHEVA, Tsvetelina STOILOVA

Agricultural Academy, Institute of Plant Genetic Resources, 2 Druzhba Street, Sadovo, Bulgaria

Corresponding author email: nikolaya_velcheva@abv.bg

Abstract

Agrifood system includes the totality of the stakeholders, interactions and decisions that contribute to agricultural production. Small farms are highly vulnerable to climate change because most depend on weather conditions, especially rainfall, cultivate small areas in mountainous areas and hard-to-reach areas, and do not have access to technical or financial support. Local and traditional varieties play an important role, as a resource for breeding, sustainable crop diversity in farms or to compliment diets with organic products. Plant diversity grown in small holdings in Bulgaria is characterized by a large number of crops: vegetables, grain legumes, medicinal and aromatic species. The sustainable production of horticultural crops provides a key part of the healthy food. Our aim is to explore developing of conserved collections through new information strategies, supporting free access to plant gene fund. The study provides information on crop diversity in rural areas using the survey method and analysing the passport data from conducted collection missions. Based on results argent activity plan to improve protection of these valuable plant genetic resources for guarantee our food and agriculture will be recommended.

Key words*: climate changes, horticultural crops, landraces, data base, genebank.*

INTRODUCTION

Agri-food system includes the totality of the stakeholders, interactions and decisions that contribute to agricultural production. Small farms are highly vulnerable to climate change because most depend on weather conditions, especially rainfall, cultivate small areas in mountain areas and hard-to-reach areas, and do not have access to technical or financial support. This fact makes them priority areas for conservation (Matthies et al., 2023).

Plant genetic resources are cultivated and wild forms, local populations, old, traditional and improved varieties carrying a functional unit for heredity and possessing actual or potential value to science and practice (ITPGRFA, 2009).

Plant genetic resources provide the basis for sustainable agricultural production, adaptation to climate change, and economic development. Home gardens have allowed the adaptation and domestication of plants to extreme or specific ecological conditions, thus contributing to the diversification of cultivated plants. They provide opportunities to broaden the base of cultivated plant materials by underutilized crop plants and crop wild relative (Korpelainen, 2023).

The maintenance of plant genetic diversity through seeds of cultivated species and their wild relatives at national, regional and international levels, as well as promoting access to and equitable sharing of benefits arising from the use of these resources and associated traditional knowledge, is one of the objectives for FAO sustainable development goals (https://www.fao.org/sustainable-development-goals/indicators/251a/en/).

Fundamental and applied scientific research in the field of plant breeding in public, private and non-profit organizations nationally and internationally aim to reduce further biodiversity loss and respond of food demand under climate change scenarios. Achieving this one priority task is possible through the efficient use of genetic resources and traditional ecological knowledge about them. A stimulating factor is the provision of full-fledged free access to the gene pool stored in the gene banks, which also gives one a powerful long-term perspective on the effectiveness of the global conservation system plant biodiversity. (Engels and Ebert, 2021; Louafi et al., 2021).

Management of *ex situ* collections includes activities such as collection, research, evaluation, documentation and storage of plant

germplasm, for the preservation of the diversity of species, appropriate use of their genetic potential selection, recovery in practice, full access and exchange (CBD, 2011). The main purpose of the genebanks is to represent the widest diversity of the gene pool and to make it free accessible (Dostatny et al., 2021).

The role of plant genetic resources stored in genebanks covers various effects on the environment and the socio-economic status of the population, both in rural and in the urban areas of the country. Landraces play an important role in the nutrition of people, as well as being a valuable donor of qualities to the breeding programs for the creation of modern varieties with high quality and high biological value (Villanueva et al., 2017). Identifying the link between climate change, agrobiodiversity, food security and healthy nutrition is the subject of comprehensive research activities (Muluneh, 2021). The global trend of reducing agrobiodiversity is a threat to the sustainability of agricultural production, respectively, and for the food chain. The role of home gardens as repositories of biological diversity has been acknowledged (Galluzzi et al., 2010; Vinatoru et al., 2019; Bratu et al., 2022).

The plant gene pool is a resource for creating innovations and finding new applications of existing crops and to develop improved varieties that provide food, feed, fuel, medicine and other raw materials for the world economy. After completing the acclimatization stage, the landraces are subjected to intensive breeding works, obtaining new genotypes with distinct phenotypic expressiveness (Negosanu et al., 2021; 2023; Bratu et al., 2023). Wild relatives are evaluated as potential sources of useful signs for the adaptation of crop plants to changing conditions (Mattana et al., 2021). The genetic variation in landraces caused by the specific factors of environment, shapes plant diversity (Bellon et al., 2015).

Landraces are an agri-food and historical-cultural heritage but are undergoing losses worldwide (Giupponi et al., 2021). Bulgaria is taking action to counteract this problem by following European guidelines. One of the important measures is the maintenance of National Register of local plant genetic resources.

The purpose of the study is to explore developing of conserved *ex situ* collections of Bulgarian landraces, preserved *on farm*, through new information strategies, supporting free access to plant gene pool in the context of their socio-economic significance.

MATERIALS AND METHODS

The National Programme of Conservation of Plant Genetic Resources for Food and Agriculture in Bulgaria has the following priorities: (1) conservation of cultural and historical heritage and present created values expressed in plant genetic resources for present and future generations and (2) contribution to national development, food safety, sustainable agriculture and agrobiodiversity management by means of conservation and utilisation of plant genetic resources for food and agriculture.

The National Seed Genebank at Institute of Plant Genetic Resources – Sadovo was established in 1984. The activities are carried out according to the FAO Genebank Standards (2014) for long-term conservation under controlled conditions.

The Information Centre was established in 1982 and it was renewed in 2021 under the BGPLANTNET project "Establishment of National Information Network GeneBank – Plant genetic resources", financed by the Bulgarian National Science Fund. The seed accessions are documented in an electronic database, according to the descriptors of FAO/Bioversity (2017). Passport information includes: catalogue number, taxonomic description, accession name, date of registration, biological status, donor and geographical origin. The database is organized as an electronic register which provides the ability to sort and analyse the status and the enrichment by descriptors.

During the period 1982-2023 collection missions for local horticultural varieties and populations were conducted to summarize the information available for the germplasm of local accessions collected from their typical growing regions, allowing their rational use in breeding and practice (Krasteva, 2007). Local farmers that preserve landraces *on farm* proved fundamental to create an inventory of

traditional varieties and prevent the genetic erosion of landraces (Stoilova and Pereira, 2013). The landraces inventory was elaborated following the methodology of Maxted et al. (2019).

The study is using the survey method regarding the purpose of landraces cultivation in agricultural holdings by collecting accessions, interviewing farmers and analysing the passport data from conducted expeditions in rural areas.

Data were organized in Excel sheets with different fields: common name of the landraces, species, genus, family, elevation, latitude, longitude, municipality, region, farmer. Geographic coordinates and elevation were acquired through GPS from the farm/home garden of the private grower of the specific landrace. and database. The analysis was performed using MySQL software (Velcheva et al., 2023).

RESULTS AND DISCUSSIONS

Local accessions stored in the Bulgarian genebank collections are the result of the direct collection of seeds donated by farmers as a specific population, belonging to a certain locality and cultivated for traditional use. Due to its specific geographical location, diverse relief and climate features Bulgaria is distinguished by a rich botanical diversity that is used since ancients in traditional cuisine and local medicine.

Total amount of landraces registered in the passport database reached 11,063 (Table 1) and this figure is close to the real status of collections from expeditions (excluding not high number of duplications and some new accessions not yet registered in collection).

Table 1. Status of landraces in Bulgarian genebank collection (National Register, Date check 29.02.2024)

Crop groups	Number of accessions	% in the collection
Cereals	1,539	14 %
Grain legumes	2,907	26 %
Forages	1,668	15 %
Vegetable	3,951	36 %
Medical and aromatic plants	590	5 %
Others	408	4 %
Total	11,063	100 %

The largest collections are vegetables (36 %) and grain legumes (26%), followed by forages and cereals. Bulgarian genebank provides available passport data to the European web catalogue EURISCO (http://eurisco.ecpgr.org).

It was found that plant diversity grown in small holdings in Bulgaria is characterized by a large number of crops: vegetables, grain legumes, medicinal and aromatic species. The role of access to information on conserved plant biodiversity for achieving sustainable development of the regions can be considered in several directions – their participation in the agro-food chain, for production of traditional products, provide varietal diversity in local markets, as well as in rural tourism. Last but not least, local varieties have potential in relation to return of people to rural areas, hobby gardening and biological production. The role of access to gene pool information comes into focus on the biological, agricultural, social and economic prospects for use of these resources and traditional knowledge related to their cultivation, a time when society is sensitive to ecology and challenges, caused by climate change, with a growing need for higher yields and more well adapted crops. As a result of enrichment, collections were enriched with valuable landraces of genus *Phaseolus*, *Capsicum*, *Cucurbita*, *Allium, Lycopersicon*, etc. (Figure 1).

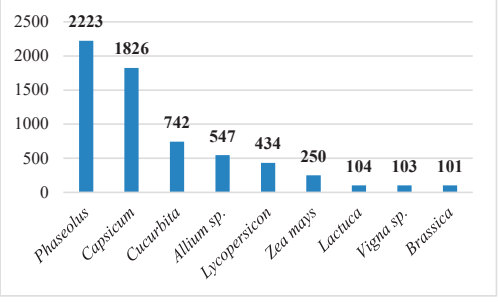

Figure 1. Number of collected landraces per crop

The highest percentage of *Phaseolus* collection (2083 acc. *Ph. vulgaris* L., 131 acc. *Ph. coccineus* L. and 9 acc. *Phaseolus* sp.) are collected from home gardens throughout mountains Rhodopes (700-1000 m), Balkan (500-650 m), Rila (700-1300 m), Pirin (700-900 m) and semi-mountain region of South and North Bulgaria (150-350 m). More than 100

accessions are collected from the villages near each of the region Smolyan, Velingrad, Devin, Samokov, Blagoevgrad, Troyan, Veliko Tarnovo, which makes these areas as hot spots of traditional *Phaseolus* varieties. Collected varieties of beans were identified, contributing greatly to the richness of this family at a national level. Likewise, 1825 acc. pepper (*Capsicum annuum* L.), 434 acc. of tomatoes (*Lycopersicon esculentum* Mill.), were collected from different parts of the country. This is linked to the climatic conditions and the dietary role of these plant genetic resources. Only the varieties that can develop at higher altitude such as Fabaceae can be found in Rhodopes, an almost totally mountainous region, while Trakya valley is rich in *Poaceae*, *Solanaceae* and *Cucurbita* landraces that can grow in the specific conditions. *Fabaceae*, *Solanaceae* and *Cucurbitaceae* together comprise 60% of all landraces. 80% of local beans are mostly preserved/grown in areas between 150 and 800 m. The sub-mountain and mountain areas are hotspots of traditional varieties due to anthropic and environmental factors (Figure 2).

Figure 2. Hot spots of landraces in mountain and semi-mountain areas in Bulgaria

Dobrudzha, historically considered one of the most important Bulgarian areas for wheat production, turned out to be very poor in *Poaceae* landraces, differently from most of the other regions of the country, probably due to the use of modern commercial varieties with the consequent loss of traditional cultivars. Strandzha, a hilly region characterized, has preserved many *Poaceae*, *Solanaceae*, and *Cucurbitacae* landraces thanks to the presence of traditional varieties. For example, the maize (*Zea mays*) landraces, despite being *Poaceae* crop, are good examples of conserved agro-ecotypes in home gardens. Plovdiv-Pazardzhik is the richest region in horticulture landraces, probably due to the climatic conditions and the unique logistics of the agri-food sector. The areas richest in number of landraces and in different crops cultivated as landraces were located inland in hilly and mountainous areas that are characterized by high environmental diversity. In these areas with a high level of agrobiodiversity are set *on farm* conservation of plant genetic resources were identified through a methodological approach using the criteria presence of landrace diversity and specific agroclimatic conditions, considering their additive advantages as local markets, rural tourism, consumers are ready to pay higher price for good taste of the traditional products. Landraces (*Fabaceae*, *Poaceae* and *Solanaceae*) are those containing landraces cultivated in a wide altitudinal range (from 0 to over 1300 m) but concentrated in sub-mountain areas (150-800 m). This is due to the fact that these families contain plants adaptable to, and grown in, these environments, such as beans (*Phaseolus* sp.), rye (*Secale cereale*), potatoes (*Solanum tuberosum*) and *Allium* sp. Landraces from *Fabaceae* family are cultivated in hilly, sub-mountain and mountain areas and 80% are local beans. Rye landraces are cultivated in hilly and sub-mountain areas. Potato landraces are mostly grown from 300 to 1200 m.

The particular environmental conditions of hilly and mountain areas, difficulties in communication, neglection, isolation, and traditional rural methods have guaranteed that varieties specifically adapted to those territories developed, becoming landraces as pulses, vegetables, cereals, forages, spices, etc.

The structure of farms from which seeds were collected from local varieties are different depending on the specifics of the area, but are generally small, aimed at satisfying the needs of the particular household. They are mainly

used heirloom seeds that have been kept for many years in the family and are also livelihood for rural communities (Ulian et al., 2020). As a result of the enrichment and organized database of passport description of samples are created conditions for mapping the local gene pool, which is geographical, ecologically and culturally related to the region of cultivation. They exist justified prerequisites for expanding the expedition activity in specific regions of the country, rich in valuable plant resources - folk selection aimed mainly at selection for taste, fruit size, disease resistance. A high potential interest is revealed here connection with the achievement of a sustainable bioeconomy. The assessment of the value of plant genetic resources and their direct using local markets can contribute significantly to the conservation of agro-biodiversity while contributing to rural resilience communities (Balogh et al., 2016). Local varieties are a source of valuable qualities and biological characteristics that are preferred by consumers. The effective one however, a strategy for the protection of agrobiodiversity is closely related to the economic one value of products, therefore increasing attention to sustainable is needed foods, linking traditional agricultural productions with cultural and rural tourism (Brush et al., 1998). Awareness of the role of plant diversity in local farm will significantly increase the effectiveness of the strategy for its conservation.

Old local tomato varieties were well recognized in the past, but are now very poorly known, with the exception of the beef heart type ("Momino sarce", "Aleno sarce"). The most popular landraces of the Cucurbitaceae family grown in Bulgaria include "watermelon from Lubimetz", melon "Medena rosa" and pumpkin species type "Tsigulka" and "Big white". Minor crops - medicinal and aromatic plants, are very diverse and abundant in their natural habitats where the most abundant are species which have been cultivated for a long time, including chamomile, mint, lemon balm, valerian, thyme, and others.

In addition to the loss of genetic diversity, the significant loss of traditional knowledge on the use and growing of such varieties is evident. Thus, today only populations kept by poor households in marginal remote regions can survive, due to their inability to pay for commercial seed material. Families engage in food production for subsistence or small-scale marketing as well as knowledge related to agricultural practices is transmitted. Specific activities as *on farm* conservation could have a positive influence to the sustainability of the mountain and semi-mountain regions (Table 2).

Table 2. Indicators of conservation and reintroduction of landraces in mountain and semi-mountain areas

On farm as a conservation tool	*On farm* as a social catalyst	*On farm* as an income
• Sustainable management of resources • Environmental improvement • Local awareness about environmental and social problems • Biodiversity conservation • Investment in conservation and development of rural products	• Increased self-reliance, confidence and motivation for community development • Redefinition of local economy structure • Strengthening local cuisine, culture and heritage • Safety network for households with low incomes	• Migration of young people to villages • Local farmers economic benefits • Economic benefits to the villages • Some impacts on other economic sectors as tourism • Local community development projects

Small holdings make a significant contribution to crop production in a number of horticulture traditional varieties that are characterized by high labour intensity and a low level of mechanization. Small holdings make a significant contribution to the formation of rural communities and the sustainable development of rural areas. The data contained in the National Register reflect the situation of local plant diversity *ex situ/on farm* conservation and knowledge. As shown by this study, mountain and semi-mountain areas are hotspots of agrobiodiversity and a resource for sustainable, innovative, and quality agri-food chains.

The future perspectives to improve the protection and increase the free access to these valuable landraces:

- Improvement of cooperation between the sectors of agriculture and environment protection, which are responsible for the global biodiversity conservation in Bulgaria.
- Improvement of cooperation between the institutions involved in the plant genetic resources management and all users of the genebank potential.
- Support for creation of non-governmental organizations, which would be more involved in conservation of traditional local varieties.

- Development and financing of projects oriented to students' education in biodiversity preservation practises.

CONCLUSIONS

During last 40 years Bulgarian genebank has managed to collect a fairly large number of accessions of local and traditional varieties of diverse crops and their wild relatives. Although most of this material has been fairly well managed there are still gaps to be filled.

The study shows that at the current stage, despite the reduction of small holdings in the mountain and semi-mountain areas, they have a great socio-economic importance and role in the *on farm* conservation; support the vitality of hard-to-reach areas; play an essential role in supporting household incomes; have an essential role in increasing the sustainability of agriculture through the revival of specific local productions with added value, cultural and rural tourism, etc.

The datasets and analysis in this research will be useful to all stakeholders (civil society, farmers, and governance as well as researchers) as it provides information on distribution of Bulgarian landraces and can be trigger actions of their evaluation, characterization, access, and utilization of these resources.

In the future the National Register will be supplemented with details, describing conducted collection missions and that information will be made available via a web-enabled catalogue, part from Information System of Bulgarian genebank, following the recommendations of ECPGR (2021).

ACKNOWLEDGEMENTS

This research work was carried out with the support of Bulgarian National Science Fund under the project КП-06-Н56/13/19.11.2021 "Bioactive compounds of legume and medicinal plants – properties and potentials for use under changing climatic conditions".

REFERENCES

Balogh, P., Békési, D., Gorton, M., Popp, J., Lengyel, P. (2016). *Consumer willingness to pay for traditional food products*. Food Policy. 61, 176–184. https://doi.org/10.1016/j.foodpol.2016.03.005.

Bellon, M. R., Gotor, E., Caracciolo, F. (2015). *Conserving landraces and improving livelihoods: how to assess the success of on-farm conservation projects?* International Journal of Agricultural Sustainability, 13(2), 167-182, DOI: 10.1080/14735903.2014.986363.

Bratu, C., Stanica, F., Vinatoru, C., Musat, B., Negosanu, G., Popescu, M. (2023). *Preliminary results on the acclimatization of a new species of the Solanaceae family in Romania*. Scientific Papers. Series B, Horticulture, Vol. LXVII, Issue 1, Print ISSN 2285-5653, 533-538.

Bratu, C., Stanica, F., Vinatoru, C., Popescu, M., Musat, B., Negosanu, G., Burlan, F. (2022). Evaluation and conservation of germplasm resources of Solanum melongena L. owned by plant genetic resources bank Buzău. Scientific Papers. Series B, Horticulture, Vol. LXVI, Issue 1, Print ISSN 2285-5653, 420-428.

Brush, S., Meng, E. (1998). *Farmers' valuation and conservation of crop genetic resources.* Genetic Resources and Crop Evolution, 45, 139–150.

CBD (2011). *Nagoya protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilisation to the Convention on Biological Diversity.* United Nations Environmental Programme.

Dostatny, D. F., Korzeniewska, A., Bartoszewski, G., Rawski, R., Kaźmińska, K., Gelvonauskis, B. (2021). *The Evaluation and Conservation of Plant Genetic Resources Collected in Lithuania.* Agronomy, 11 (8): 1586. https://doi.org/10.3390/agronomy11081586.

ECPGR. (2021). *Plant Genetic Resources Strategy for Europe.* European Cooperative Programme for Plant Genetic Resources, Rome, Italy.

Engels J., Ebert, A. (2021). *A Critical Review of the Current Global Ex Situ Conservation System for Plant Agrobiodiversity.* I. History of the Development of the Global System in the Context of the Political/Legal Framework and Its Major Conservation Components. Plants, 10(8), 1557. https://doi.org/10.3390/plants10081557.

FAO (2014). *Genebank Standards for Plant Genetic Resources for Food and Agriculture.* Rome. Italy.

FAO/Bioversity (2017). *Multi-Crop Passport Descriptors.* Rome. Italy. https://www.ecpgr.cgiar.org/fileadmin/templates/ecpgr.org/upload/EURISCO/EURISCO_MCPD2_descriptors_updated_November_2017.pdf

Galluzzi, G., Eyzaguirre, P., Negri, V. (2010). *Home gardens: neglected hotspots of agro-biodiversity and cultural diversity.* Biodiversity and conservation, 19, 3635-3654, https://doi.org/10.1007/s10531-010-9919-5.

Giupponi, L., Pedrali, D., Leoni, V., Rodari, A., Giorgi, A. (2021). *The Analysis of Italian Plant Agrobiodiversity Databases Reveals That Hilly and Sub-Mountain Areas Are Hotspots of Herbaceous Landraces.* Diversity. 13(2):70. https://doi.org/10.3390/d13020070.

Korpelainen, H. (2023). *The role of home gardens in promoting biodiversity and food security.* Plants, 12(13),2473, https://doi.org/10.3390/plants12132473.

Krasteva, L. (2007). *Collection and evaluation of local vegetable genetic resources in Bulgaria.* Acta Horticulturae, 729, 73-76, DOI: 10.17660/ActaHortic.2007.729.8.

Louafi, S., Thomas, M., Berthet, E. T., Pélissier, F., Vaing, K., Jankowski, F., Bazile, D., Pham, J.-L., Leclercq, M. (2021) *Crop Diversity Management System Commons: Revisiting the Role of Genebanks in the Network of Crop Diversity Actors.* Agronomy, 11(9): 1893. https://doi.org/10.3390/agronomy11091893.

Mattana, E., Ulian, T., Pritchard, H. W. (2021). *Seeds as natural capital. Trends in Plant Science,* 27(2), 139-146. https://doi.org/10.1016/j.tplants.2021.08.008.

Matthies, A. E., Fayet, C. M., O'Connor, L. M., Verburg, P. H. (2023). *Mapping agrobiodiversity in Europe: Different indicators, different priority areas.* Ecological Indicators, 154, 110744, https://doi.org/10.1016/j.ecolind.2023.110744.

Maxted, N., Veteläinen, M., Negri, V. (2019) *Landrace Inventories: Needs and Methodologies.* In European Landraces on-farm Conservation Management Use, University of Perugia, Italy, pp. 45–68.

Muluneh, M. G. (2021). *Impact of climate change on biodiversity and food security: a global perspective - a review article.* Agriculture & Food Security, 10(1), 1-25. https://doi.org/10.1186/s40066-021-00318-5.

Negosanu, G., Vinatoru, C., Peticila, A., Barcanu, E., Agapie, O. L., Tanase, B., Gherase, I. (2021). *Phenotypic expressiveness of new Sideritis scardica genotypes obtained at Vegetable Research and Development Station Buzău*. Scientific Papers. Series B, Horticulture, Vol. LXV, Issue 1, Print ISSN 2285-5653, 527-533.

Negosanu, G., Vinatoru, C., Peticila, A., Musat, B., Bratu, C., Asanica A. (2023). *Evaluation of phenotypic expressivity of Sideritis scardica var. ossa, a new genotype acclimated and bred in Romania*. Scientific Papers. Series B, Horticulture, Vol. LXVII, Issue 1, Print ISSN 2285-5653, 811-816.

Stoilova, T., Pereira, G. (2013). *Assessment of the genetic diversity in a germplasm collection of cowpea (Vigna unguiculata (L.) Walp.) using morphological traits.* African Journal of Agricultural Research, 8(2), 208-215.

Ulian, T., Diazgranados, M., Pironon, S., Padulosi, S., Liu, U., Davies, L., Howes, M.-J.R., Borrell, J., Ondo, I., Pérez-Escobar, O. A., Sharrock, S., Ryan, P., Hunter, D., Lee, M. A., Barstow, C., Łuczaj, Ł., Pieroni, A., Cámara-Leret, R., Noorani, A., Mba, C., Womdim, R. N., Muminjanov, H., Antonelli, A., Pritchard, H. W., Mattana, E. (2020). *Unlocking plant resources to support food security and promote sustainable agriculture.* Plants, People, Planet, 2(5), 421-445, DOI: 10.1002/ppp3.10145.

Velcheva, N., Stoyanova-Doycheva, A., Cheperigova, S. (2023). *Data management and development of documentation system for plant genetic resources in Bulgaria.* Rastenievdni Nauki, 60(2).

Villanueva, A. B., Halewood, M., Noriega, I. L. (2017). *Agricultural Biodiversity in Climate Change Adaptation Planning.* European Journal of Sustainable Development, 6(2), 1-8. https://doi.org/10.14207/ejsd.2017.v6n2p1.

Vinatoru, C., Musat, B., Bratu, C., Peticila, A. (2019). *Results and perspectives in Ocimum basilicum (basil) breeding at Vegetable Research and Development Station Buzău*. Scientific Papers. Series B, Horticulture, Vol. LXIII, Issue 2, Print ISSN 2285-5653, 161-168.