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Corresponding Author
Gökhan ASKAN
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CC BY 4.0**Koruma, Üretim ve Sergi Entegrasyonuna Dayalı Endemik Doğal Bitki Koleksiyon Bahçesi Tasarımı: Erzincan Bahçe Kültürleri Araştırma Enstitüsü Örneği****Gökhan ASKAN^{1*}, Meral ASLAY²**¹Dr. Öğr. Üyesi, Binali Yıldırım Üniversitesi, Erzincan; ORCID: 0000-0002-4342-2970²Zir.Yük.Müh., Bahçe Kült.Araş. Enst., Erzincan; ORCID: 0000-0002-8966-0149

Küresel biyolojik çeşitlilik kaybı, ekolojik koruma ile sürdürülebilir yönetim modellerinin bütüncül biçimde ele alınmasını zorunlu kılmaktadır. Dar yayılış alanlarına ve özgül ekolojik gereksinimlere sahip endemik taksonlar bu süreçten daha fazla etkilenmekte ve hem *in situ* hem de *ex situ* koruma stratejilerini gerektirmektedir. Bu çalışma, Erzincan Bahçe Kültürleri Araştırma Enstitüsü yerleşkesinde koruma-üretim-sergi entegrasyonu temelinde geliştirilen endemik ve doğal bitki koleksiyon bahçesi tasarımını mekânsal bir model çerçevesinde değerlendirmektedir. Araştırma; (i) literatür temelli kavramsal çerçeve oluşturulması, (ii) alanın iklim, topoğrafya ve (iii) toprak özelliklerine yönelik ekolojik analizler, çok kriterli tür seçimi ve (iv) bilgisayar destekli mekânsal planlama aşamalarından oluşan çok aşamalı bir metodoloji ile yürütülmüştür. Envanter çalışmaları sonucunda koleksiyon bahçesinde toplam 48 bitki taksonu belirlenmiş ve bunların 20'sinin Türkiye endemiği olduğu tespit edilmiştir. Tür kompozisyonunun ağırlıklı olarak geofit karakterli olduğu ve özellikle *Fritillaria* cinsi etrafında yoğunlaştığı belirlenmiştir. Fonksiyonel zonlama; koruma, çoğaltım, sergi, eğitim ve kontrollü satış birimlerini kapsayacak şekilde ekolojik uygunluk ve kurumsal sürdürülebilirlik ilkeleri doğrultusunda planlanmıştır. Bulgular, koleksiyon bahçelerinin yalnızca *ex situ* koruma alanı değil, aynı zamanda araştırma altyapısı, genetik kaynak yönetim platformu ve bölgesel kalkınmayı destekleyen çok işlevli mekanlar olduğunu ortaya koymaktadır. Ayrıca TÜBİTAK ve TAGEM destekli projeler ile akademik iş birlikleri, bahçenin bilimsel üretim ve sektörel katkı potansiyelini güçlendirmektedir.

Design of an Endemic and Native Plant Collection Garden Based on the Integration of Conservation, Propagation, and Exhibition Functions: The Case of Erzincan Horticultural Research Institute

Global biodiversity loss requires integrated ecological conservation and sustainable management approaches. Endemic taxa with restricted distributions and specialized ecological requirements are particularly vulnerable, necessitating both *in situ* and *ex situ* conservation strategies. This study presents the design of a native and endemic plant collection garden proposed for the Erzincan Horticultural Research Institute campus, developed through a conservation-propagation-exhibition integration model within a systematic spatial planning framework. The research followed a multi-stage methodology: (i) establishing a literature-based conceptual framework, (ii) conducting ecological analyses of climate, topography, and soil, (iii) applying multi-criteria species selection, and (iv) implementing computer-aided spatial design. Inventory results identified 48 plant taxa, including 19 endemics to Türkiye, with a dominance of geophytes, particularly species from the genus *Fritillaria*. The garden was structured through functional zoning, incorporating conservation, propagation, exhibition, education, and controlled sales units, aligned with ecological suitability and institutional sustainability. The findings indicate that such collection gardens serve not only as *ex situ* conservation sites but also as research infrastructures, genetic resource management platforms, and multifunctional landscapes that contribute to biodiversity conservation and regional development.

INTRODUCTION

Global biodiversity loss is widely recognized as one of the most critical environmental challenges of the 21st century. Habitat destruction, land-use changes, climate change, and increasing anthropogenic pressures have driven species into a rate of decline far exceeding their natural extinction rates. In particular, narrow-range and endemic taxa are disproportionately affected by these processes due to their restricted geographic distributions and specific ecological requirements. Accordingly, contemporary plant conservation strategies are no longer based solely on the protection of natural habitats (in situ), but also incorporate *ex situ* conservation mechanisms-such as botanical gardens, seed banks, and living collections-as complementary and supportive tools (Donaldson, 2009; Mounce et al., 2017).

Although botanical and collection gardens were historically established for aesthetic and recreational purposes, they have evolved into multifunctional scientific centers in the modern era. These institutions undertake a wide range of roles, including the management of living collections, taxonomic and systematic research, conservation of genetic diversity, phenological monitoring, environmental education, and the promotion of public awareness (Chen & Sun, 2018).

Global assessments indicate that the number of species conserved in botanical gardens has reached a significant level, and that these collections function as “insurance populations” for threatened species (Mounce et al., 2017). In addition, the social, educational, and economic contributions of botanical gardens are increasingly emphasized, and these institutions are regarded as sustainability-oriented spatial and institutional structures (BGCI, 2017).

Türkiye attracts considerable attention due to its high species diversity and an endemism rate exceeding 30%, largely attributable to its location at the intersection of the Mediterranean, Irano-Turanian, and Euro-Siberian phytogeographical regions, as well as the presence of unique biogeographical formations such as the Anatolian Diagonal. Studies on the spatial distribution of endemic plant species indicate that Eastern Anatolia constitutes a significant center of endemism (Şenkul & Kaya, 2017).

In this context, Erzincan province possesses a rich floristic composition, owing to its position at the intersection of steppe, mountainous, and valley ecosystems, as well as its altitudinal variation and microclimatic diversity. Research on the flora of Erzincan reveals that the province hosts numerous

local and narrowly distributed taxa, particularly geophytic species (Kandemir et al., 2022).

The conservation of endemic and native plant species is not only an ecological necessity but also of strategic importance for the continuity of cultural heritage, local identity, and the sustainability of biological resources. Contemporary conservation approaches are no longer limited to the preservation of biodiversity; rather, they require the development of integrated models that also encompass economic sustainability and public participation. One of the approaches that has gained prominence in recent years involves integrating conservation efforts with production infrastructures, regulated plant trade, and exhibition and educational facilities (BGCI, 2017; Chen & Sun, 2018).

Such integrated models strengthen financial sustainability, enhance the participation of local stakeholders, and support long-term conservation capacity. In particular, the propagation of native and endemic species and their use in landscape applications establish a functional bridge between biodiversity conservation objectives and regional development.

Despite the increasing number of studies emphasizing the conservation role of botanical gardens, the majority of existing research primarily focuses on either biodiversity conservation, ornamental landscape design, or educational functions separately. Studies integrating conservation, propagation, exhibition, controlled plant production, and spatial planning within a single multifunctional model remain limited, particularly in the context of endemic geophyte collections in Türkiye. Moreover, there is a lack of applied spatial planning models specifically developed for research institute campuses located in continental climatic regions such as Eastern Anatolia. In this respect, the present study differs from conventional botanical garden approaches by proposing an integrated conservation-production-exhibition framework supported by ecological suitability analysis, functional zoning, and conservation-oriented species prioritization.

From a spatial planning perspective, the success of collection gardens depends on the appropriate zoning of functional areas, the determination of plant composition based on ecological compatibility, the design of visitor circulation systems that support educational experiences, and the fulfillment of the technical requirements of production areas. The discipline of landscape architecture holds the potential to develop sustainable spatial models by integrating ecological, scientific, and socio-economic parameters within a holistic framework.

The evaluation of physical parameters such as climatic data, soil characteristics, topography, accessibility, and visual relationships together with species-specific habitat requirements and maintenance needs enables the formulation of sustainable design decisions based on a conservation-use balance.

Within this theoretical framework, the study examines a proposed native and endemic plant collection garden located within the campus of the Erzincan Horticultural Research Institute. The site holds a distinctive position due to its significant regional potential for geophyte collections and its status as one of the limited numbers of specialized geophyte collection gardens in Türkiye. Furthermore, the area functions as an active research infrastructure supporting both undergraduate and graduate-level academic studies.

Within the scope of the research, the climatic, topographic, and edaphic characteristics of the site were analyzed, and, based on the obtained data, functional areas were planned at the implementation scale using computer-aided design (CAD) tools. Production, exhibition, sales, and educational units were structured within a systematic spatial organization framework, and the spatial integrity of the design, along with user experience, was evaluated through three-dimensional visualizations.

During the species selection process, native and endemic taxa specific to the region were identified based on criteria such as ecological suitability, landscape value, maintenance requirements, and potential economic uses.

In this context, the study focuses on the following research questions:

1-How can endemic plant collection gardens be aligned with regional and national conservation strategies?

2-How can production and sales functions be integrated without conflicting with biodiversity conservation objectives?

3-How can spatial planning principles enhance the educational, scientific, and social functions of the collection garden?

The spatial model developed on the basis of conservation-production-exhibition integration is intended to present an applicable and replicable approach within the context of endemic plant-based landscape planning in Türkiye. Accordingly, the study aims to develop a sustainable, functional, and multidimensional planning and design framework for collection gardens to be established at the scale of research institutions.

Furthermore, the proposed model is expected to contribute to both the theoretical literature and

practical landscape planning applications by supporting the conservation, propagation, and promotion of endemic plant species. The conceptual framework presented in Figure 1 illustrates the integrated structure of the collection garden model, which is based on the interaction of conservation, propagation, exhibition, education, and sustainable economic support functions. Together, these components contribute to biodiversity conservation, *ex situ* preservation, scientific research infrastructure, public awareness, and regional development within a multifunctional landscape planning framework.

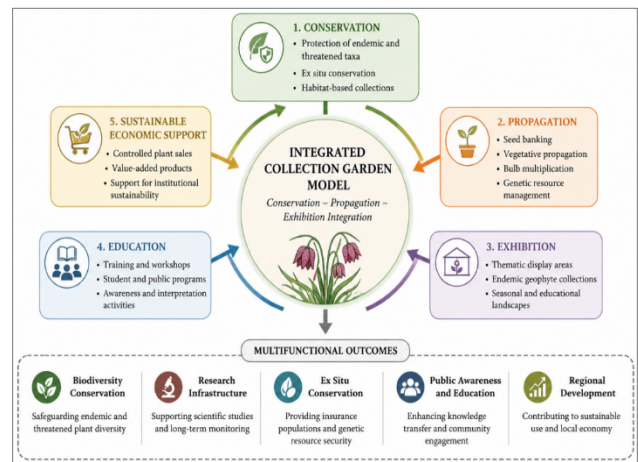


Figure 1. Conceptual framework of the integrated conservation propagation display collection garden model

The originality of this study lies in the development of an integrated and multifunctional collection garden model for endemic geophytic plant taxa under continental climatic conditions. Unlike conventional botanical garden approaches, the proposed model combines ecological suitability analysis, conservation-oriented species selection, functional spatial planning, research and educational functions, and controlled production systems within a unified planning framework. In this respect, the study contributes to the literature by presenting a scientifically grounded and region-specific conservation-production-exhibition model for research institution campuses in Türkiye.

MATERIALS AND METHODS

Materials

The primary material of this study is the proposed native and endemic plant collection garden located within the campus of the Erzincan Horticultural Research Institute Directorate, operating under the

General Directorate of Agricultural Research and Policies (TAGEM). The institute is a regionally significant research organization in Eastern Anatolia, conducting studies on fruit growing, viticulture, vegetable production, ornamental plants, and plant genetic resources (Republic of Türkiye Ministry of Agriculture and Forestry, 2024). The institution comprises open-field experimental plots, production greenhouses, laboratory units, and applied research areas. This infrastructure provides a strong basis for structuring the proposed collection garden within both research- and production-oriented frameworks.

The study area is situated in the Upper Euphrates Basin of the Eastern Anatolia Region and is characterized by a continental climate. Erzincan province exhibits a rich floristic composition due to its location at the intersection of steppe, mountainous, and valley ecosystems, as well as its altitudinal gradients and microclimatic diversity. Floristic studies indicate that approximately 2,500 plant taxa occur naturally in Erzincan and its surroundings, a considerable proportion of which are endemic (Kandemir et al., 2022). At the national scale, Türkiye hosts more than 12,000 plant taxa with an endemism rate exceeding 30%, while Eastern Anatolia stands out as one of the most prominent regions in terms of endemic species richness (Şenkul & Kaya, 2017).

The plant material used in this study was selected from endemic and native taxa naturally distributed in Türkiye. Species selection was based on regional floristic records, herbarium data, and relevant literature (Kandemir et al., 2022). In particular, geophytic species were prioritized as the primary material group, considering the floristic character and collection potential of the region.

The spatial material of the study consists of existing land topography, soil characteristics, climatic data, current vegetation cover, production infrastructure, and transportation networks. The topographic structure and edaphic properties of the site were evaluated as key parameters in determining the location of functional zones (production, exhibition, sales, and education). In this context, the physical and biotic components of the site constitute the fundamental basis of the planning model, which is grounded in the integration of conservation, production, and exhibition within the collection garden.

The site plan of the proposed endemic plant collection garden within the Erzincan Horticultural Research Institute campus is presented in Figure 2.



Figure 2. Site plan of the proposed native and endemic plant collection garden within the campus of the Erzincan Horticultural Research Institute

Method

This study was conducted within the framework of a holistic spatial planning approach aimed at developing a native and endemic plant collection garden design based on the integration of conservation, production, and exhibition. Ecological analyses, literature review, spatial design techniques, and species selection criteria were evaluated in an integrated manner.

The methodological process was carried out in four stages: (i) literature review and conceptual framework analysis, (ii) site analysis, (iii) determination of plant selection and evaluation criteria, and (iv) development of the spatial planning and design model.

Literature Review and Conceptual Framework Development

The theoretical foundation of the study was established based on international research focusing on the ex-situ conservation role of botanical gardens, principles of sustainable landscape planning, and multifunctional collection garden models. A conceptual model was developed within the framework of the role of botanical gardens in the conservation of threatened species (Mounce et al.,

2017), their function in scientific research and public engagement (Chen & Sun, 2018), and their contribution to sustainability (Donaldson, 2009).

In addition, studies evaluating the economic, social, and environmental impacts of botanical gardens (BGCI, 2017) contributed to the development of a holistic planning approach.

Study Area Analysis

The physical and ecological characteristics of the study area, which form the basis for the spatial planning process, were analyzed through a comprehensive and holistic approach. Within the scope of the 3,600 m² site, topographic structure and slope analyses were conducted; climatic evaluations were carried out based on long-term temperature and precipitation averages; edaphic (soil) properties were examined; and the existing vegetation cover and habitat characteristics were identified.

The analytical process is theoretically aligned with the “planning based on natural data” approach proposed in Ian McHarg’s (1969) ecological planning framework. Accordingly, ecological suitability was adopted as the primary determining criterion in the spatial distribution and positioning of functional areas, and natural thresholds and potentials were considered as the principal data inputs in the formulation of planning decisions.

Conservation-Oriented Species Prioritization and ex situ Adaptation Criteria

Rather than selecting species based primarily on ornamental landscape preferences, the study adopted a conservation-oriented prioritization approach focusing on the ex-situ preservation of native and endemic taxa. In this framework, the primary objective was not to identify species suitable for conventional landscape use, but to determine taxa requiring conservation support and evaluate their adaptation potential under controlled cultivation conditions.

In order to strengthen the species selection process, a multi-criteria evaluation framework was applied during the prioritization of endemic and native taxa. Each species was evaluated based on six main criteria: (i) endemism status, (ii) conservation importance, (iii) regional distribution characteristics, (iv) *ex situ* propagation potential, (v) ecological compatibility with the site conditions, and (vi) suitability for creating sustainable microhabitats within the collection garden.

Each criterion was scored on a scale between 1 (low suitability) and 5 (high suitability). Species with higher total scores were prioritized within the spatial planning and planting design process. This evaluation

framework enabled a more systematic and transparent determination of conservation-oriented plant selection decisions. The regional floristic characteristics and conservation priorities of the taxa were supported by the floristic data presented by Kandemir et al. (2022) and the spatial distribution analyses of endemic species in Türkiye reported by Şenkul and Kaya (2017). The multi-criteria evaluation system used in species selection is presented in Table 1.

Table 1. Multi-criteria evaluation framework used in species selection

Criteria	Evaluation Description	Score Range
Endemism status	Whether the species is endemic to Türkiye	1-5
Conservation status	IUCN threat category	1-5
Ecological suitability	Adaptation to Erzinçan climate and soil conditions	1-5
<i>Ex situ</i> propagation potential	Suitability for controlled propagation and cultivation	1-5
Landscape value	Visual and exhibition potential	1-5
Habitat sensitivity	Degree of pressure on natural habitats and conservation necessity	1-5

Spatial Planning and Design Process

Functional zoning was carried out based on the results of site analyses and plant selection criteria. The functional zoning framework developed for the collection garden is illustrated in Figure 3.

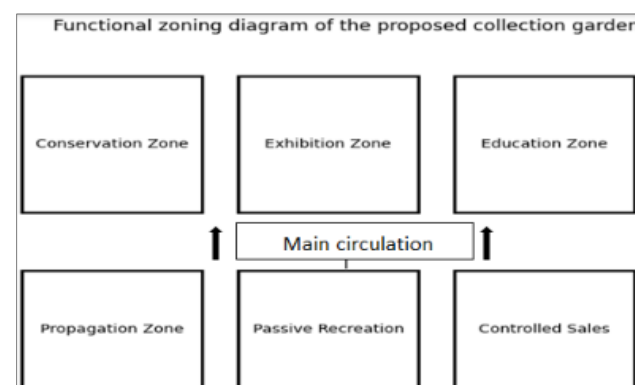


Figure 3. Functional zoning diagram of the proposed collection garden

The design process encompassed the preparation of the needs program, the identification of functional areas and the calculation of their sizes, the planning of circulation systems and user flow, and the development of the planting design composition. Spatial planning was prepared at a scale of 1:100 using computer-aided design (CAD) tools, and the spatial integrity and visual impact of the design were systematically evaluated through three-dimensional modeling techniques.

The conservation-production-exhibition integration model was structured based on the

multifunctional botanical garden approach emphasized by Chen & Sun (2018) and BGCI (2017). Within this model, conservation (endemic species collections and genetic preservation), production (propagation and adaptation), exhibition (interpretation and visitor information), and sales (controlled and sustainable trade) functions were designed as complementary subsystems.

RESULTS AND DISCUSSION

Within the scope of the study, the plant species within the collection garden were systematically identified, and the taxa determined through field observations and inventory studies were recorded at the family, genus, and species levels. During the species identification process, expert opinions were consulted, and both the taxonomic verification and the determination of the taxonomic risk (threat) categories of the species were carried out based on the Turkish Plants Data Service (TÜBİVES, 2025), Plants of the World Online (POWO, 2025), and the floristic references provided by Yücel (2005). As a result of the inventory studies, a total of 48 plant taxa were identified for use in the collection garden. Of these, 19 taxa were determined to be endemic to Türkiye, significantly enhancing the biodiversity value of the site. The majority of the identified taxa belong to the genus *Fritillaria*, followed by species from the families Asparagaceae and Iridaceae. In addition to endemism status, the IUCN threat categories of the taxa were also evaluated in order to determine the conservation significance of the collection. The presence of threatened taxa classified under categories such as CR (Critically Endangered), EN (Endangered), and VU (Vulnerable) demonstrates the importance of the collection garden in supporting *ex situ* conservation strategies. The distribution of endemic and non-endemic taxa within the collection garden is presented in Figure 4.

Quantitative evaluation of the floristic composition revealed that 39.6% of the identified taxa were endemic to Türkiye (19 out of 48 taxa). In terms of family distribution, the family Liliaceae constituted the dominant group within the collection, primarily represented by species belonging to the genus *Fritillaria*. The family-based distribution of taxa indicates the dominance of the family Liliaceae within the collection Figure 5.

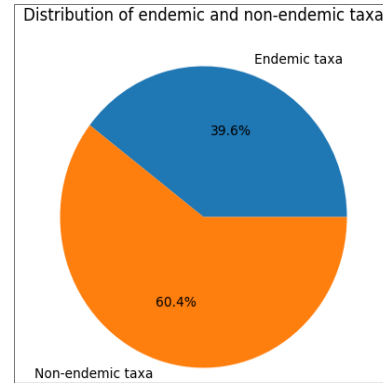


Figure 4. Distribution of endemic and non-endemic taxa within the collection garden

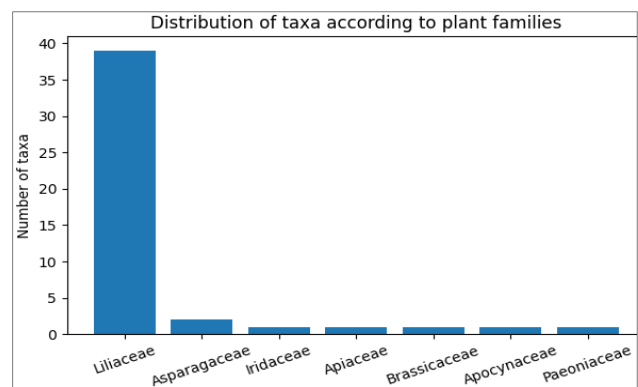


Figure 5. Distribution of taxa according to plant families

Geophytic species formed the major component of the collection, reflecting the floristic identity and ecological characteristics of Eastern Anatolia. Unlike conventional botanical garden models that are primarily organized for ornamental display and recreational use, the proposed collection garden model was structured as an integrated system combining *ex situ* conservation, scientific research infrastructure, propagation facilities, educational functions, and controlled commercial production. Previous studies have emphasized the scientific and conservation roles of botanical gardens (Donaldson, 2009; Chen & Sun, 2018); however, spatially integrated models focusing specifically on endemic geophyte collections adapted to continental climatic conditions remain limited in Türkiye. In this respect, the proposed model contributes to the literature by presenting a region-specific and multifunctional planning framework based on ecological suitability, conservation priorities, and sustainable management principles. Furthermore, the integration of breeding projects, academic collaborations, and propagation infrastructure distinguishes the collection garden from traditional display-oriented botanical garden approaches.

The dominance of geophytes indicates the suitability of the collection garden for the conservation and exhibition of bulbous plant taxa adapted to continental climatic conditions. In addition, the concentration of endemic and threatened taxa within the collection highlights the ecological and conservation significance of the proposed garden model.

The list of plant species identified within the study area is presented in Table 3.

Some of the plant species identified in the study area are presented in Figure 6. The species included in the figure were selected to represent the floristic

diversity and endemic character of the collection garden.

Table 2. Quantitative evaluation of floristic composition

Parameter	Value
Total number of taxa	48
Number of endemic taxa	19
Endemism ratio	39.5%
Dominant family	Liliaceae
Dominant genus	Fritillaria
Dominant life form	Geophytes

Table 3. Plant species identified in the study area and their endemism status

No	Scientific Name	Family	Turkish Name	Endemism Status	CR/EN/VU/NT/LC
1	<i>Fritillaria aurea</i> Schott	Liliaceae	Damalıale	Endemic	EN
2	<i>Fritillaria raddeana</i> Regel	Liliaceae	-	-	LC
3	<i>Fritillaria crassifolia</i> Boiss. & Huet	Liliaceae	Boynubükük	Endemic	LC
4	<i>Fritillaria kurdica</i> Boiss. & Noe in Boiss.	Liliaceae	Bozlale	-	LC
5	<i>Fritillaria imperialis</i> L.	Liliaceae	Ağlayan gelin	-	LC
6	<i>Fritillaria michailovskyi</i> Fomin	Liliaceae	Sarı dudak	Endemic	EN
7	<i>Fritillaria pinardii</i> Boiss.	Liliaceae	Mahcuplale	-	LC
8	<i>Fritillaria assyriaca</i> Baker	Liliaceae	Donuklale	-	LC
9	<i>Fritillaria persica</i> L.	Liliaceae	Kırklale	-	LC
10	<i>Fritillaria latifolia</i> Willd.	Liliaceae	Yaylalalesi	-	LC
11	<i>Fritillaria sororum</i> Jim.Persson & K.Persson	Liliaceae	-	-	EN
12	<i>Fritillaria zagrica</i>	Liliaceae	-	-	-
13	<i>Fritillaria amana</i> (Rix) Tekşen	Liliaceae	Maraşlalesi	Endemic	EN
14	<i>Fritillaria hakkarensis</i> (Rix) Tekşen	Liliaceae	Hakkarılalesi	Endemic	EN
15	<i>Fritillaria straussii</i> Bornm.	Liliaceae	Ayıklale	-	EN
16	<i>Fritillaria alburyana</i> Rix	Liliaceae	Pembelale	Endemic	EN
17	<i>Fritillaria platyptera</i> Sam. ex. Rech.f	Liliaceae	Meşelalesi	-	-
18	<i>Fritillaria glaucoviridis</i> Turill	Liliaceae	Yaşlale	Endemic	-
19	<i>Fritillaria bithynica</i> Baker	Liliaceae	Delilale	-	EN
20	<i>Fritillaria milasensis</i> Teksen & Aytaç	Liliaceae	Milaslalesi	Endemic	EN
21	<i>Fritillaria viridiflora</i> Post	Liliaceae	Yeşillale	Endemic	EN
22	<i>Fritillaria stribrnyi</i> Velen	Liliaceae	Gariplale	-	LC
23	<i>Fritillaria asumaniae</i> R.Wallis, R.B.Wallis & Özhatay	Liliaceae	Asumanlalesi	Endemic	EN
24	<i>Fritillaria uva-vulpis</i> Rix	Liliaceae	Ayılalesi	-	EN
25	<i>Fritillaria mughlai</i> Teksen & Aytaç	Liliaceae	Muğlalalesi	Endemic	EN
26	<i>Fritillaria sibthorpiana</i> (Sm.) Baker	Liliaceae	Makılalesi	-	-
27	<i>Fritillaria enginiana</i> (Byfield & Özhatay) Tekşen	Liliaceae	Enginlalesi	Endemic	EN
28	<i>Fritillaria acarica</i> Rix	Liliaceae	Bodursarı	-	LC
29	<i>Fritillaria byfieldii</i> Özhatay & Rix	Liliaceae	Uzunlale	Endemic	EN
30	<i>Fritillaria latakiensis</i> Rix	Liliaceae	Karalale	-	EN
31	<i>Fritillaria minima</i> Rix	Liliaceae	Karalalesi	Endemic	EN
32	<i>Fritillaria minuta</i> Boiss. & Noë	Liliaceae	Kınalıale	-	EN
33	<i>Fritillaria caucasica</i> Adam	Liliaceae	Kaflalesi	-	LC
34	<i>Fritillaria baskilensis</i> Behçet	Liliaceae	Baskılalesi	Endemic	EN
35	<i>Fritillaria armena</i> Boiss.	Liliaceae	Şarklalesi	-	EN
36	<i>Fritillaria kittaniae</i> Sorger	Liliaceae	Narinlale	Endemic	EN
37	<i>Fritillaria frankorum</i> R.Wallis & R.B. Wallis	Liliaceae	Saphılale	-	EN
38	<i>Fritillaria elwesii</i> Boiss.	Liliaceae	Sürmelilale	-	LC
39	<i>Tulipa sprengeri</i> Baker	Liliaceae	Yitik Lâle	-	CR
40	<i>Vinca soneri</i> Koyuncu	Apocynaceae	Pegirççeği	Endemic	EN
41	<i>Paeonia mascula</i>	Paeniaceae	Şakayık	-	LC
42	<i>Gagea</i> spp.	Liliaceae	Sarıyıldız	-	EN
43	<i>Ornithogalum</i> spp.	Asparagaceae	Akyıldız	-	-
44	<i>Tulipa armena</i> var. <i>armena</i>	Liliaceae	Dağ lalesi	-	LC
45	<i>Iris iberica</i> subsp. <i>elegantissima</i>	Iridaceae	Kurt kulağı	Endemic	LC
46	<i>Muscari armeniacum</i>	Asparagaceae	Dağ sümbülü	-	-
47	<i>Hesperis isatidea</i> (Boiss.) D.A.German & Al-Shehbaz	Brassicaceae	Allı Gelin	Endemic	EN
48	<i>Smyrniolum connatum</i> Boiss. & Kotschy	Apiaceae	Yabani kereviz	-	LC

CR: Critically Endangered; EN: Endangered; VU: Vulnerable; NT: Near Threatened; LC: Least Concern.



Fritillaria imperialis L.

Vinca soneri Koyuncu



Hesperis matronalis (Boiss.) D.A.German & Al-Shehbaz

Figure 6. Some of the plant species identified in the study area

Academic Studies and Publications

The collection garden has been evaluated not only as a plant conservation area but also as an active scientific research platform supporting the documentation and *ex situ* conservation of endemic and native taxa. In this context, interdisciplinary collaborations were carried out with the Department of Biology, Faculty of Arts and Sciences at Erzincan Binali Yıldırım University. Within the scope of these collaborations, studies focusing on the reproductive biology, propagation characteristics, and ecological adaptation of endemic geophyte species were conducted.

A master's thesis on the reproductive biology of *Fritillaria assyriaca* subsp. *assyriaca* was completed within the Department of Biology. In addition, scientific studies related to the reproductive biology and conservation-oriented evaluation of *Fritillaria aurea*, *F. michailovskyi*, and *F. imperialis* were published in international peer-reviewed journals. These studies contributed to the scientific documentation of endemic taxa and strengthened the role of the collection garden as a research and conservation infrastructure (Figure 7).

Academic studies conducted within the collection garden have primarily focused on species collection, documentation, monitoring, and *ex situ* conservation practices. In this respect, the collection garden functions as a scientific platform supporting the sustainable conservation of regional plant diversity and endemic geophyte taxa.



Figure 7. Scientific contributions of the collection garden to endemic species and its added value to national research capacity

Academic studies conducted to date for the establishment of the collection, focusing on the collection and documentation of the existing taxa.

Three breeding projects have been successfully completed within the collection garden. These projects have made significant contributions to the domestication and commercialization processes of *Fritillaria* species in Türkiye:

- TÜBİTAK 106G022 “Domestication of Some Perennial Plant Species in Eastern Anatolia (*Fritillaria* spp. and *Tchihatchewia isatidea*)” (2006-2009);

- TÜBİTAK 110G007 “Cultivar Development in Turkish *Fritillaria* L. Species and Introduction of New Varieties to the Sector” (2010-2015);

- TAGEM/BBAD/17/A09/P09/05 “Cultivar Development in Turkish *Fritillaria* L. (Crown Imperial) Species and Introduction of New Varieties to the Sector” (2017-2022).

The breeding materials obtained through these projects have strengthened the genetic resource conservation capacity of the collection garden, while the newly developed cultivars have been introduced into the ornamental plant sector. This demonstrates that the garden constitutes a distinctive model in terms of integrating conservation and economic functions.

The Importance of the Collection Garden as a Source of Plant Material for Pharmaceutical and Pharmacological Research

Plant material from the collection garden has also been utilized as a raw material source in pharmacological research. Within the scope of a collaborative study conducted with the Faculty of Pharmacy at Atatürk University, the pharmacological properties of *Fritillaria michailovskyi* tubers were investigated. The plant material used in the study entitled “Anticholinesterase Potential and Volatile Component Profile Characterized by SPME-GC-MS of Endemic *F.michailovskyi* Plants Obtained from Different Harvest Periods in Türkiye” was directly supplied from the collection garden.

In addition, plant material was provided for a doctoral research project conducted at the Faculty of Pharmacy, Biruni University, entitled “Determination of the Phytochemical Properties and Biological Activities of *Fritillaria imperialis* L. and *Fritillaria pinardii* Boiss.”, as well as for a BAP project titled “Phytochemical Properties and Cholinesterase Inhibition Potentials of *Fritillaria imperialis* L. and *Fritillaria pinardii* Boiss.”.

The cultivation of endemic species under controlled conditions is considered to be critically important, as it ensures the standard quality of samples while reducing destructive pressure on natural populations. This finding highlights the potential contribution of the collection garden to biomedical research infrastructure.

Contribution of the Collection Garden to Environmental Education and Knowledge Transfer

In addition to its conservation function, the collection garden has served as an applied learning environment supporting environmental education, knowledge transfer, and capacity-building activities related to the conservation and sustainable cultivation of native geophytic taxa.

Within the scope of the social responsibility project titled “The Journey of Hennaed Hands with Crown Imperial (*Fritillaria*)”, practical training activities on crown imperial cultivation were organized for Ahıska women farmers. These activities contributed not only to rural development and the preservation of traditional knowledge, but also to the dissemination of conservation-oriented cultivation practices for endemic plant species (Figure 8).

In addition, practical training sessions organized within the collection garden for researchers from the Nezahat Gökyiğit Botanical Garden contributed to the dissemination of conservation-oriented knowledge on geophyte propagation and cultivation.

These activities also supported the development of specialized human resources and reinforced the role of the collection garden as a platform for scientific knowledge production, applied education, and inter-institutional knowledge transfer. With appropriate planning and design approaches, collection gardens can be transformed into multifunctional spaces that serve not only as conservation areas but also integrate educational, research, propagation, and exhibition functions. In line with this approach, a model site planning framework was developed.

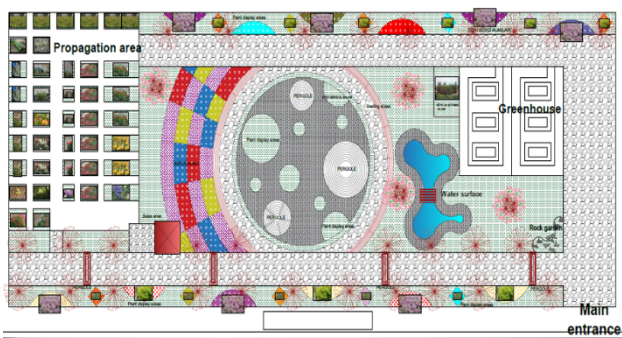


Figure 8. Practical training on crown imperial (*Fritillaria*) cultivation provided to Ahıska women farmers

Spatial Planning Model for Multifunctional Collection Gardens

The spatial design process of the collection garden was carried out using computer-aided design methods in line with the institutional needs program and functional requirements. Initially, considering the existing site conditions, topographic data, and functional demands, a site plan at the implementation scale (1:100) was prepared in the AutoCAD environment. At this stage, spatial zoning decisions for production, exhibition, sales, and educational units were determined, and the circulation system, open space organization, and planting design areas were planned.

Design of an Endemic and Native Plant Collection Garden Based on the Integration of Conservation, Propagation, and Exhibition Functions: The Case of Erzinçan Horticultural Research Institute



Plant Exhibition Areas



Primary Entrance Area



Passive Recreation Areas



Ecological Pond Areas



Transitional Pergolas Between Functional Areas



Plant Production Greenhouses

Figure 9. General view of the collection garden designed within the campus of the Erzinçan Horticultural Research Institute

The prepared two-dimensional plan schemes were visualized using three-dimensional modeling software to evaluate the spatial integrity and volumetric relationships of the design. The three-dimensional simulation process enabled the analysis of the impact of planting composition within the space, the user perspective, and the visual continuity between functional zones. Thus, both the technical feasibility and the perceptual dimension of the design decisions were systematically assessed.

This method is consistent with digital modeling and visualization techniques commonly used in landscape planning studies and provides a measurable and documentable framework for the design process. Visuals of the proposed design are presented in Figure 9.

CONCLUSION

Within the scope of this study, the proposed endemic plant collection garden located within the campus of the Erzinçan Horticultural Research Institute was evaluated within the framework of a holistic spatial model based on the integration of conservation, production, and exhibition. The findings reveal that the proposed model is not merely an aesthetically oriented landscape arrangement; rather, it constitutes a multidimensional system that

simultaneously integrates *ex situ* conservation, the strengthening of scientific research infrastructure, sustainable management of genetic resources, and educational functions.

In this context, sustainable urban and resilient campus planning processes should be addressed through an integrated approach that incorporates the use of native and endemic plant species (Yılmaz & Askan, 2025). The role of botanical gardens and collection areas in the conservation of plant genetic resources has been clearly emphasized in the literature. In particular, *ex situ* conservation strategies are recognized as playing a complementary role alongside *in situ* approaches in ensuring the sustainability of biodiversity (Heywood, 2017; Volis, 2017). Moreover, the functions of botanical gardens in research, education, and public awareness are considered key components of global biodiversity conservation policies (Mounce et al., 2017). In this regard, the proposed collection garden model presents a framework that is consistent with international conservation approaches.

The identification of a total of 48 species belonging to six different families within the study area, including taxa endemic to Türkiye and exhibiting natural distribution patterns, highlights the high biodiversity value and ecological significance of the site.

This finding highlights the significant potential of the area in terms of both conservation and scientific research. On the other hand, spatial arrangements in landscape planning and design should not be solely human-centered but should be addressed within a holistic framework that considers the habitat requirements of all living organisms (Askan & Yılmaz, 2025).

The dominance of geophytic species within the species composition, particularly the concentration around the genus *Fritillaria*, demonstrates a strong alignment with the floristic identity of Eastern Anatolia. Türkiye is recognized as a globally significant gene center, especially in terms of geophytic species, while the Eastern Anatolia Region holds a prominent position due to its high endemism rate (Ekim et al., 2000; Davis et al., 1988). This situation indicates that the proposed collection garden possesses strategic potential for the representation and conservation of regional genetic resources.

The preference for plant species adapted to local ecological conditions in the open green spaces of Erzincan is considered an important strategy for enhancing the climate change adaptation capacity of urban landscapes (Askan & Yılmaz, 2016).

The model developed based on the integration of conservation, production, and exhibition is observed

to establish a functional balance between biodiversity objectives and economic sustainability. It is also emphasized in the sustainable development literature that plant collections can contribute to local economies through flora tourism and thematic landscape applications (Ballantyne et al., 2011).

The study conducted by Askan et al. (2024) at Erzincan Binali Yıldırım University demonstrated that xeriscape garden applications based on native plant species contribute to the sustainability of natural flora at the urban scale. In particular, the visual attractiveness created by geophytic species during their flowering periods is considered a significant factor that enhances visitor experience and reinforces spatial identity.

The adoption of an ecologically based zoning approach in the spatial planning process enabled the positioning of functional areas on a scientific basis. Data-driven decision-making processes in landscape planning are recognized as effective in ensuring the conservation of ecosystem services and the promotion of sustainable land use (Ahern, 2013). In addition, the use of digital modeling and three-dimensional visualization techniques as decision-support tools in design processes contributes to pre-implementation performance evaluations.

For future studies, it is recommended to support long-term phenological monitoring, population-based genetic diversity analyses, and visitor experience assessments with quantitative indicators. The evaluation of conservation performance through measurable indicators will enable collection gardens to be included in national and international comparative analyses (Volis, 2017).

One of the principal contributions of this study is the development of a multifunctional collection garden model specifically adapted to the ecological and climatic conditions of Eastern Anatolia. Unlike many existing botanical garden studies that predominantly focus on conservation or visual landscape value independently, the proposed framework integrates conservation, propagation, research, education, and controlled economic use within a unified spatial planning approach. Therefore, the study contributes to the literature not only through species conservation but also by proposing a replicable institutional planning model for endemic plant-based landscape systems in Türkiye.

In conclusion, this study demonstrates that endemic plant collection gardens can be structured through a multifunctional and holistic design model at the intersection of landscape planning, biodiversity conservation, and sustainable development. The proposed model represents an applicable, scalable, and adaptable framework for regions with high

endemism potential and contributes to scientifically grounded spatial planning approaches at the scale of research institutions.

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