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Technical Article

Jardim de Sequeiro: a rainfed garden technique, innovative in aesthetics and environmental quality, inspired by the Cerrado

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Abstract

The "Jardim de Sequeiro" (rainfed garden) is an innovative technique of naturalistic and seasonal rainfed gardening developed by Prof. Julio Pastore and a team of professionals and students at the University of Brasilia (UnB). The first experimental garden was planted at the Instituto Central de Ciências (ICC), an iconic brutalist building at the University of Brasília and a landmark of modern Brazilian architecture. The garden extends through the 732 meters of the mega-structure, encompassing more than 5,000 square meters of rooftop gardens planted on a thin layer of soil. The experimental garden is primarily grown from seeds, making it a dynamic space. Beginning with fast-growing species, plants bloom in succession throughout the summer and early autumn. The garden is "rainfed," relying entirely on rainfall for water, and it withers and dries with the onset of the winter drought. As such, it can be considered a garden-installation: a temporary occupation that is redesigned and improved every year. Conceived and planned during the initial months of the COVID-19 pandemic, the garden's first cycle occurred between December 2020 and May 2021, when the university was closed. Despite the difficulties inherent to the pandemic period, the innovative nature of the project has yielded promising results.

Keywords: garden design, landscape architecture, nature-based solutions, sustainability.

Resumo

Jardim de Sequeiro: uma técnica paisagista inovadora na estética e na qualidade ambiental, inspirada no Cerrado

O "Jardim de Sequeiro" é uma técnica inovadora de jardins naturalistas, sazonais e sem irrigado pela chuva desenvolvido pelo Prof. Julio Pastore e um time de profissionais e estudantes na Universidade de Brasília (UnB). O primeiro jardim experimental foi plantado no Instituto Central de Ciências (ICC). Um icônico edifício brutalista da Universidade de Brasília e um marco da arquitetura moderna brasileira. O Jardim estende-se ao longo dos 732 metros da megaestrutura totalizando 5.000 metros quadrados de jardim sobre laje plantado sob uma fina camada de solo. O jardim experimental é plantado majoritariamente por sementes, criando um espaço dinâmico. Iniciando pelas espécies mais precoces, as plantas florescem em sucessão do verão até o início do outono. O jardim de sequeiro é plantado durante a estação chuvosa, dependendo inteiramente das chuvas, e seca com a chegada da estiagem de inverno. Assim, pode-se considerá-lo um jardim-instalação: uma ocupação temporária que é redesenhada e aprimorada a cada ano. Concebido e plantado durante os primeiros meses da pandemia da COVID-19, o primeiro ciclo do jardim ocorreu entre dezembro de 2020 e maio de 2021, enquanto a universidade esteve fechada. Apesar das dificuldades apresentadas pela pandemia a natureza inovadora do projeto trouxe resultados promissores.

Palavras-Chave: arquitetura da paisagem, paisagismo, soluções inspiradas na natureza, sustentabilidade.,

Introduction

Cerrado is the original biome of Brasilia, the capital of Brazil, currently the third most populous city in the country as indicated by the 2022 Census (IBGE, 2022). The city has its original complex designed by Lúcio Costa in the 1950s listed as a World Heritage Site due to its exceptional architectural and urbanistic value (UNESCO, 1987).

Since its conception, the relationship between the city of Brasilia and its landscape context, the Cerrado, has

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been explored by architecture and urbanism. Landscape architecture, with few exceptions, continued to refer to exotic references, foreign to the local landscape.

The University of Brasilia (UnB), located in the central area of the Federal capital, has a large architectural heritage designed by great Brazilian architects such as Oscar Niemeyer and João da Gama Filgueiras Lima ("Lelé"). Among the university's buildings, the most iconic is the Central Institute of Sciences (ICC Figures 1, 2, and 3)), a mega-structure more than 730 meters long that houses several of UnB's faculties and institutes. The ICC features more than 10,000 m² of rooftop gardens, composing a large expanse between the two parallel blocks that form the building. Approximately 5,000 m² of these gardens form a long central corridor, in full sun, flanked on both sides by large concrete pilasters that support the roofs of the building's two blocks.

Figure 1. Instituto Central de Ciências at University of Brasilia. Photo by Jesco von Puttkamer, 1970s. The boxes that form the garden in the central corridor are not yet filled with soil.

In the 1970s, the long open space between the building's blocks was landscaped in the modernist style, as was the case with other buildings in the capital. A palette of plants composed of grass and exotic shrubs was installed, growing on a layer of soil that rests on the roof of scientific laboratories below. For nearly fifty years, that garden was maintained with manual irrigation during the dry seasons (from May to October). However, due to the successive water crises that occurred in Brazil between 2016 and 2018, worsened by lapses in the provision of gardening services, the extensive rooftop gardens of ICC dried up, resulting in almost a total loss of its vegetation cover. Even some ancient native palms (*Syagrus oleracea* (Mart.) Becc.), over 30 years old, could not resist; their roots, so strong and deep under natural conditions, were trapped in the concrete vase.

Figure 2. Instituto Central de Ciências. Google Earth, winter season, 2017, after losing its vegetation.

Figure 3. Instituto Central de Ciências after its plants dried out. Julio Pastore, 2017.

Replanting the garden in the old way would require financial and water resources that are no longer available. So, with the aim of developing a solution for this large area on the slab, without irrigation and at low cost, in 2019, the University's landscaping service, coordinated by Professor Julio Pastore, started the "Jardim de Sequeiro" project. The plan was to plant a naturalistic, low-cost, and seasonal garden, using native grasses of the Cerrado and traditional short-cycle flowers in a naturalistic composition (Figure 4). A garden implanted by seeds that could multiply its seeds to be used in the next cycle, and its yearly design and cultivation becoming opportunities for teaching, research, and university extension activities. A naturalistic garden implanted by seeds, using native Cerrado grasses and traditional short-cycle flowers, which is planted at the beginning of each year's rains and blooms until the winter drought arrives.

The Garden was conceived by Prof. Julio Pastore, and its realization is the result of cooperation between the provision of services (Landscaping Department of Universidade de Brasília - UnB) and academic activities developed by the Laboratory of Landscape Architecture and Gardening of the Faculty of Agronomy and Veterinary of UnB. The Jardim de Sequeiro was sown for the first time in the 2020-21 rainy season by a team of 9 volunteers who participated in the development of the project. The experimental character of the garden is perpetuated by the redesign of the plant composition every year, as well as by the renewal of the team and the academic activities developed (Pastore, 2022a).

The garden involves research, teaching, and academic extension activities. The last is open to the community and includes guided workshops on watercolor, drawing, photography, native bees, fabric dyeing, floral arrangements, and others. In this paper, we report data on its composition, planting, and management, as well as the landscape results obtained.

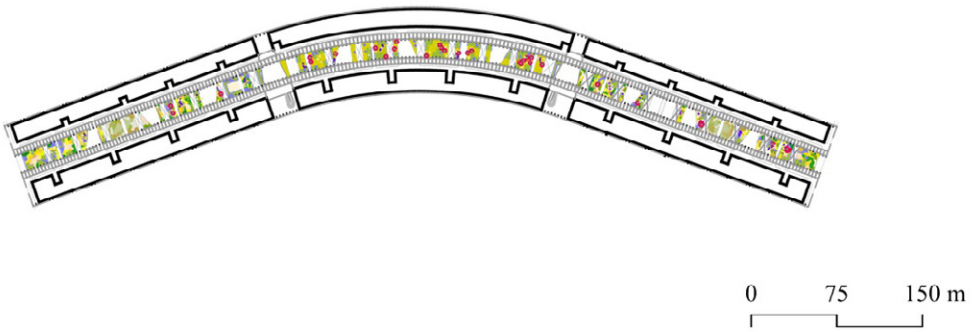

Figure 4. Jardim de Sequeiro's 2022/23 plan.

Material and Methods

Area characterization

The garden occupies the central area of the Central Institute of Science at the University of Brasilia, at coordinates -15.76407216638285, -47.87002120546229. The region has a savannah climate (Köppen and Geiger, 1928), characterized by two well-defined seasons: a hot, rainy season from October to April and a cold, dry season from May to September. The average temperature is 20.4 °C and the average annual rainfall is 1,574 mm (INMET, 2022).

The area planted on the slab is in full sun and is divided into 26 modules 15 meters wide, totaling 5,040 m². The

depth of the beds varies between 20 cm at the top and 50 cm at the bottom of the troughs. The soil has varied chemical and physical patterns, indicating a history of filling the troughs with material from different origins, generally with a clay texture.

Project conception

Jardim de Sequeiro is a concept adapted to the reality of water scarcity by creating a temporary garden that is planted during the rainy season, connecting people to the seasonality of the Cerrado (Figure 5). The composition of the garden has its references in naturalistic aesthetics and compositional techniques explored by (Hitchmough, 2017), (Oudolf, 2010) among others. These references are adapted to the local reality of the Cerrado and to its countryside formations and beauty. It is inspired by the native landscape of the Cerrado grasslands and savannas, the garden makes use of shorter plants that resemble natural fields, allowing the sewing of the central span, the building, and the rhythm of the ICC pillars.

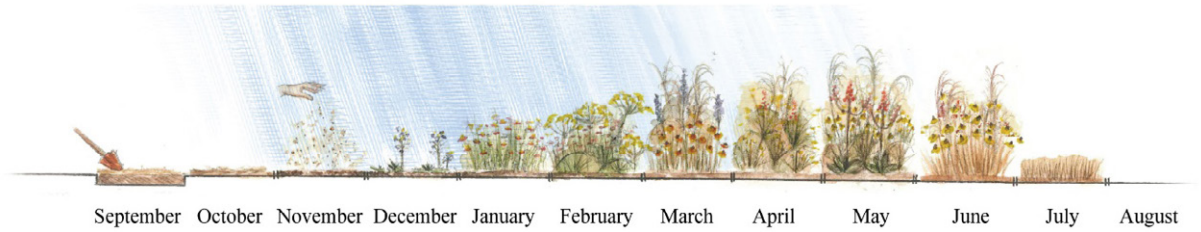

Figure 5. Jardim de Sequeiro's month activities (Nathália Bonfim, 2022).

The garden's design takes advantage of the contrast between its naturalist aesthetic and the brutalist architecture in which the garden is inserted and where concrete beams and pillars define its spaces. Moreover, the use of short stature herbaceous species allows for an unhindered view of the ICC's central span (Figure 6). The choice of species is based on creating a dynamic and evolving palette, where species succeed each other in flowering from direct sowing, with earlier or later flowers interspersed with native grasses.

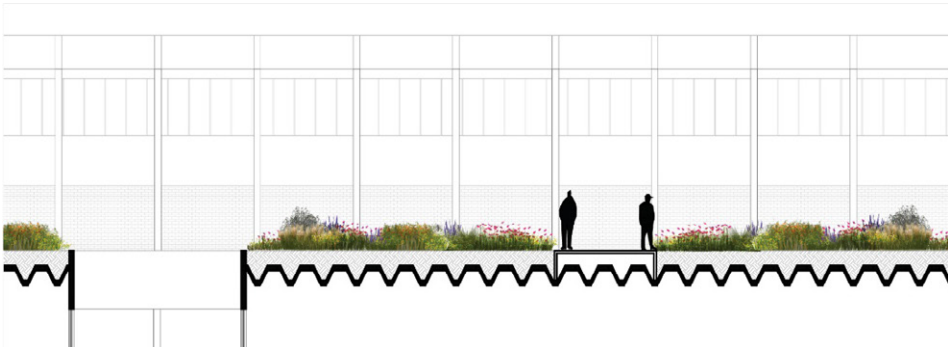

Figure 6. Instituto Central de Ciências section.

Within this compositional scheme, the species were selected to cohabit, weaving ecological relationships and presenting a dynamic density that shifts from lighter and more open formations at the beginning of the garden's cycle to a denser and more diverse meadow in its final stages.

The longevity of the garden comes from the succession of flowerings, which differs from the traditional and common monospecific flowerbeds found in the urban environment of Brasília.

The garden also innovates in the development of a direct seeding methodology, combining native grasses and traditional annual flowers, enriched by a small portion of perennial native plants.

Planting design

The planting design for the initial cycle was derived from a study of references on the arrangement of naturalistic gardens (Figure 7). This study also encompassed insights gleaned from previous small-scale experimental gardens and the inherent patterns of the Cerrado's natural formations. Furthermore, a survey of species of interest, encompassing both native and conventional varieties, was conducted.

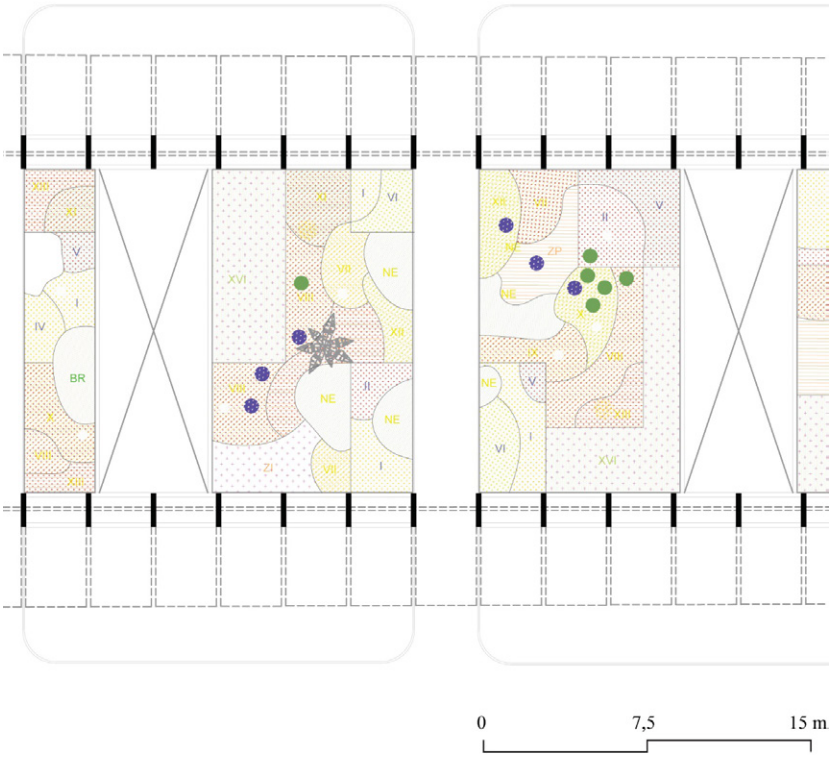

Figure 7. Jardim de Sequeiro's zommed planting design.

For subsequent cycles, the planting design primarily drew inspiration from observations made within the garden itself and in other small experimental gardens dispersed across the university campuses. Enhancements were incorporated into this design, which included novel compositional techniques and the introduction of new species.

The planting design explores the growth dynamics of the species across three layers of composition: early flowers, late flowers, and native Cerrado grasses. This innovative approach connects the garden's design with the natural rhythms of the Cerrado, creating a dynamic and evolving landscape that engages with both its ecological context and architectural surroundings.

Early flowers: Those flowering within 90 days were selected, with a light structure to allow the growth of grasses and late flowers among their foliage. In the composition, the early flowers compose open, extensive designs, with variable density and different associations. Its colors have blue as the prevailing tone, given by centaureas (*Centaurea cyanus* L.) and linseeds (*Linum usitatissimum* L.), sprinkled with warm tones of golden tickseed (*Corepsis tinctoria* Nutt.), dill (*Anethum graveolens* L.) and zinnias (*Zinnia elegans* Jacq.).

Late flowers: Species flowering after 90 days and with the ability to maintain flowering until the end of the rainy season. Late flowers, especially Salvias (*Salvia farinacea* Benth., Gaillardias (*Gaillardia* x grandiflora), were arranged in smaller and denser spots, with the function of supplanting early flowers when they lose interest, while Ornithogaluns (*Ornithogalum saundersiae* Baker) brings drama and verticality at a time when the garden would already resemble a meadow, with voluminous grasses. Besides these flowers, seedlings of the ornamental variety were also planted in monospecific patches of *Euphorbia hypericifolia* L. called euphorbia hip-hop (Figure 8).

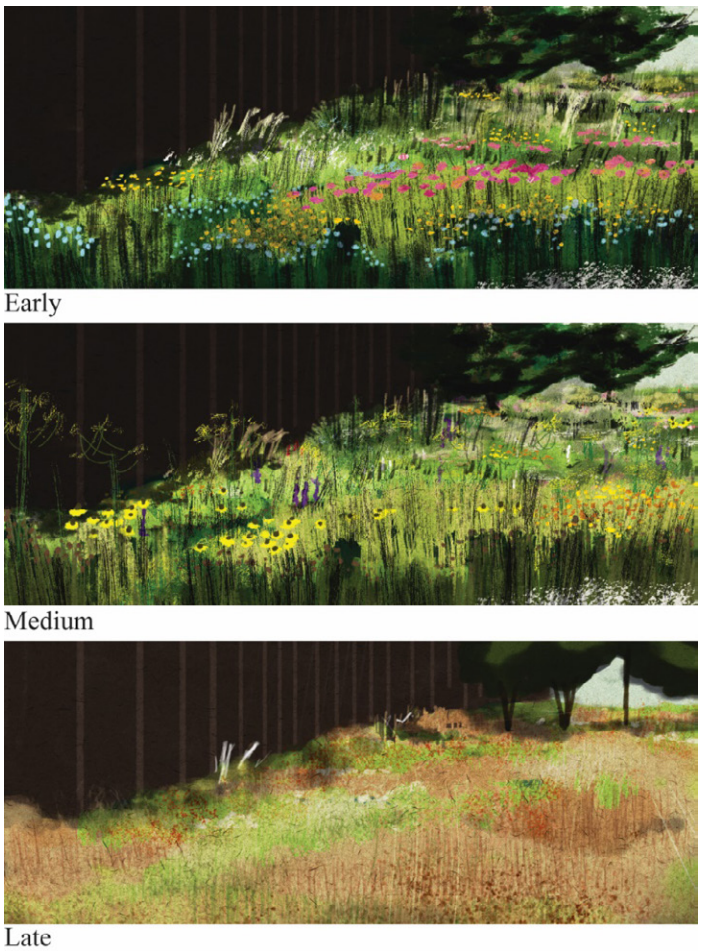

Figure 8. Succession of flowering stages.

Native Cerrado Grasses: Species previously tested in experimental gardens were selected for their ornamental interest and their ability to bloom in the first growing season after sowing.

In the grass layer, seven species of native Cerrado grasses were chosen: fastigiato grass (*Andropogon fastigiatus* Sw.), carinato grass (*Paspalum carinatum* Humb. & Bonpl. ex Flüggé), orelha-de-coelho grass (*Paspalum stellatum* Humb. & Bonpl. ex Flüggé), membeca grass (*Andropogon leuchostachyus* Kunth), fiapo grass (*Trachypogon spicatus* (L.f.) Kuntze.), brinco-de-princesa grass (*Loudetiopsis chrysothrix* (Nees) Conert), and panasco grass (*Aristida setifolia* Kunth). These grasses were distributed in large patches with sinuous progression, forming the foundation for the later flowering species.

During the 2021-22 and 2022-23 cycles, the planting design shifted to seed mixes, and the extensive patterns of overlapping layers from the previous design were abandoned. Moreover, we introduced the concept of creating a permanent backbone of native grasses, which are watered every 10 days during drought periods and remain viable from one cycle to the next.

Figure 9. Professor Julio Pastore coordinates the planting design process for each cycle. From the third cycle onwards, the entire volunteer team takes part in the species allocation.

The seed mixes comprised 3 or 4 species of early, medium, and late character, aiming to ensure a succession of flowering throughout the season. For instance: linseeds + golden tickseed + gaillardia. We enriched the plant palette with new species, such as Mexican zinnia (*Zinnia haageana* Regel), rudbeckia (*Rudbeckia hirta* L.), anise (*Pimpinella anisum* L.), and arugula (*Eruca sativa* Mill.), among others. These seed mixes were arranged in compositions of sinuous patches, ranging from 5 to 20 m², covering the north and south wings of the ICC. These patches were interspersed with native grasses and occasionally featured aloe (*Aloe Vera* (L.) Burm.) and gladiolus bulbs (*Gladiolus* sp. hybrids) seedlings. For the "central wing," a distinct design was created to accentuate the meadow nature of the garden: one mix containing 12 flowering species contrasted with another mix dominated by fastigiato grass, complemented by zinnias and linseeds.

'The use of native grasses (except for fastigiato grass, which is annual) shifted to seedlings due to the relative lack of success with direct sowing, which prevented them from blooming during the rainy season. Recognizing this, existing clumps of native grasses were watered at a low frequency during drought periods to enable their participation in subsequent cycles. Concurrently, seedlings of membeca, fiapo, prateado grass (*Anthaenantia lanata* (Kunth) Benth.), and others were cultivated in a greenhouse, enriching the base of native grasses in the garden.

Plant selection

The garden mixes annual species and native grasses in a succession of flowering stages, promoting a dynamic garden consonant with the seasonality and contrast of the dry and wet seasons that is one of the landmarks of the Cerrado landscape. Perennial and bulbous species were used to a lesser extent, and occasionally, to enrich the composition.

Table 1. Jardim de Sequeiro species / 2022/23 cycle.

Annual non-native species	**Annual native grass species**
Anethum graveolens L.	*Andropogon angustatus* (J.Presl) Steud.
Centaurea cyanus L.	*Andropogon fastigiatus* Sw.
Corepsis tinctoria Nutt.	
Eruca sativa Mill.	
Gaillardia x grandiora	
Linum usitatissimum L.	
Pimpinella anisum L.	
Rudbeckia hirta L.	
Sinapis alba L.	
Zinnia elegans Jacq.	
Zinnia haageana Regel	
Perennial non-native species	**Perennial native grass species**
Aloe Vera (L.) Burm	*Andropogon bicornis* L.
Euphorbia hypericifolia L.	*Andropogon leuchostachyus* Kunth
Gladiolus sp *hybrids*	*Anthaenantia lanata* (Kunth) Benth.
Ornithogalum saundersiae Baker	*Aristida setifolia* Kunth
Salvia farinacea Benth.	*Loudetiopsis chrysothrix* (Nees) Conert
	Paspalum carinatum Humb. & Bonpl. *ex* Flüggé
	Paspalum stellatum Humb. & Bonpl. *ex* Flüggé
	Trachypogon spicatus (L.f.) Kuntze.

The experimental nature of the garden allows for its review in each cycle to enhance its compositional foundations. The balance and composition of the species mixes are continually refined over the years, and new species are also considered for inclusion in the planting design.

Plant propagation and seeds

Two small experimental gardens were conducted in July and August 2020 to gather data and multiply seeds and bulbs for the upcoming main garden sowing. The planting material was also obtained through vegetative reproduction in the university's nursery, as well as by harvesting seeds and multiplying bulbs and plants from other areas of the UnB campus. To further enrich the garden with new species, complementary purchases and collections were made from commercial suppliers and specialized entities that focus on collecting and distributing native seeds for environmental recovery, especially since some native species are not readily available in local markets.

Starting from the second cycle, a significant portion of the seeds and plants were sourced from the garden itself, acquired through academic workshops. The collection and processing of seeds take place during the fall and early winter seasons. By August, the planting materials (seeds and bulbs) are quantified and stored in a cold room at 30% humidity and 10 degrees Celsius. In August and September, certain perennial plants are propagated through cuttings and clump division, in addition to any supplementary seed purchases. Based on the total available materials, the planting design for the subsequent cycle is then formulated.

Planting and cultivation

The seeding of Jardim de Sequeiro begins in November with the onset of the rainy season and concludes with seed harvesting and mowing during the winter drought.

Each year, the cultivation process for the garden starts with the preparation of the planting soil. The soil is tilled to a depth of 10 cm, and no chemical fertilizers or pesticides are used. Following this, a layer of leaf compost, measuring 3 to 5 cm, is applied before sowing.

Using the direct seeding technique streamlines the implementation process and eliminates the need for extensive labor. Both annual exotic and native species are introduced through direct seeding. However, it's worth noting that the planting of perennial native grasses has proven more effective when carried out using seedlings due to the longer flowering maturation period. A similar approach is taken with exotic perennial plants.

Pesticides and chemical fertilizers are not applied in this garden. The use of leaf compost as mulch has demonstrated its efficacy in improving soil quality while also suppressing the pre-existing seed bank. Importantly, this approach does not hinder the germination of the intended species. The process of marking for sowing and the actual sowing are both done manually by dedicated volunteers (Figure 10).

Figure 10. A volunteer from the Jardim de Sequeiro project rests near one of the clusters of violet Gladiolus, which were added starting from the third cycle to enhance the color palette.

Caring for the garden after planting is notably simplified and requires significantly less effort compared to traditional planting approaches. Seed germination begins within a few days of sowing, and within 14 days, it's possible to distinguish between the various seed mixes that were planted. Additional fertilization or the use of chemical pesticides is unnecessary. As the leaf compost as mulch effectively suppresses weeds, a single manual weeding session is conducted around 30 to 45 days after sowing (Figure 11).

Figure 11. Plants starting to grow.

The first species usually begin flowering within 55 to 60 days. As subsequent weeks unfold, the garden becomes progressively denser in terms of vegetation, resulting in a richer spectrum of colors and an expanded biodiversity, all of which culminates prior to the arrival of the drought season.

Results and Discussion

By now, the Jardim de Sequeiro has been planted at ICC for three years (2020-21, 21-22, and 22-23), and the 2023-24 cycle is currently in progress. In the following images, we can observe the garden's progression, tracking how the utilization of direct sowing facilitated the garden's full coverage across the designated area (Figure 12). The strategic use of seed mixes ensured a continuous sequence of blossoms right up until the conclusion of the rainy season. Additionally, it's worth noting that the garden has generated a surplus of seeds, sufficient to support its annual reseeding process. These excess seeds have either been donated or allocated to other ongoing projects.

Figure 12. View of the garden coverage.

Among the species incorporated into the garden during the initial two cycles, arugula (*Eruca sativa* L.) stood out as the only one that did not successfully acclimate to the garden environment and was consequently phased out. However, all other selected species exhibited satisfactory blooming within their projected timeframes. The seed yield for all species has proven ample for the purpose of replanting, with the exception of centaurea.

Throughout the initial three cycles (Figures 13, 14, and 15), the progress of the garden and the duration of late-species flowering were notably influenced by precipitation patterns. Gaillardias, in particular, require more than 120 days post-sowing to reach their full bloom stage. In the 2021-22 cycle, they were impacted when the rainy season concluded earlier than anticipated. The onset of drought by late March 2022 also hindered the production of fastigiato grass seeds.

Figure 13. Jardim de Sequeiro at its early stage. Linseeds and zinnias in full bloom.

Figure 14. Jardim de Sequeiro at its medium stage. Coreopsis and rudbeckias b

Figure 15. Jardim de Sequeiro at its late stage.

The establishment of a naturalistic garden at the Central Institute of Sciences has led to a noticeable increase in the variety of insects frequenting the area. Visitors can now readily observe butterflies, exotic and native bees, and other such creatures.

From the perspective of its impact as a landscaping project, the experience has become a reference within the university, evident in several internal reports, as well as a key point in the discussions and formulation of the University of Brasília's Master Plan.

On a broader scale in the field of Landscape Architecture, Jardim de Sequeiro received recognition at the 5th Latin American Biennial of Landscape Architecture, securing first place in the Built Work category (VBLAP, 2022).

The project's achievements have also resonated nationally. The Inhotim Institute, located in Brumadinho/MG, sought a partnership with UnB and initiated the implementation of a Sequeiro garden at its headquarters (Almeida et al., 2022).

The cultural impact of the garden has been documented through local and national newspaper articles and televised reports (Silva, 2021; Freire, 2022; Mendes, 2022; Pol, 2023; Blainer and Barreto, 2023). The garden has also cultivated a significant presence on social media platforms, where both team members and community members share photos and videos online. The project's digital footprint was captured by Soares (2023).

A total of 46 free workshops, facilitated by volunteers, were offered, encompassing guided tours and a variety of workshops (photography, watercolor, floral arrangement, edible flowers, identification and management of native bees, and seed collection and processing). These workshops were open to both the academic community and the wider public, resulting in more than 1,500 applications for participation (Figure 16, 17). The garden is an initiative that unites academic activities and the administrative management of landscaping services at the University of Brasília. The project has received strong support from the university's administration.

Figure 16. Extension activities at the garden, 2021-22 cycle.

Figure 17. Extension activities at the garden, 2022-23 cycle.

The Jardim de Sequeiro team is rejuvenated every year and includes volunteers, students, and university employees who are responsible for the fieldwork. They play a central role in all aspects of garden construction, extension activities, and media communication for each cycle. The team has grown from 9 individuals in the 2020-21 cycle to 26 in 2021-22, further expanding to 40 in 2022-23 and maintaining that number in the 2023-24 cycle (Figure 18).

Figure 18. Participants from 2023/24's cycle.

Conclusions

The Jardim de Sequeiro is innovative in our context in several aspects. It stands out for its unique approach to creation through sowing, its seasonal nature, its ability to thrive without irrigation despite being situated on a rooftop, its utilization of native grasses and herbaceous plants, and the naturalistic language of its composition. Its primary objectives include gaining a deeper understanding of the life cycle and ecological requirements of the species it incorporates, expanding its range of plant species, developing strategies for weed control and drought resilience, and refining design strategies to enhance aesthetic accomplishments.

Jardim de Sequeiro harnesses the seasonality of the savannah climate as a pivotal element in its aesthetics and cultivation approach. This not only contributes to arousing interest in the local landscape but also encourages the exploration of solutions that are well-suited to the region's climatic conditions and its rich potential for flourishing.

As an experimental project, it serves as a platform for fostering teaching, research, and academic extension activities, all of which are closely interlinked with the university's service offerings and the enhancement of its public spaces.

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Author Contribution

JBP: main designer of Jardim de Sequeiro's plan, coordinator of the garden management team, garden photographer, and main author. **PHH: d**eveloped drawings of the garden, created tables, and provided assistance in the garden implementation.

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