SEEDLING TRANSPLANTATION: AN ALTERNATIVE TO RESTORING DEGRADED AREAS?

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Abstract
The lack of public and institutional mechanisms to guarantee funds for executing degraded area recovery plans in Brazil is a major cause of unsuccessful restoration projects. This study aimed to test the immediate transplantation of native seedlings from natural areas to restore an area in Moeda, Minas Gerais, degraded by gravel extraction. Two planting methods were used: one with hydrogel in the planting hole and the other without. Sixty-two individuals from eleven species were rescued through random walks near the area, using a garden shovel. The planting season, the presence of ants and armadillos in the area, and the soil conditions at the site may have affected the survival rate. *Hymenaea courbaril* L. exhibited the highest survival rate, followed by *Platypodium elegans* Vogel and *Solanum lycocarpum* A.St.-Hil. The results for *Acrocomia aculeata* (Jacq.) Lodd. ex Mart. and *H. courbaril* indicate that the species' survival in the area was not influenced by hydrogel in the planting holes.

Keywords: Conservation. Degraded area recovery. Native seedling survival.

Area of Knowledge: Forest Engineering

Introduction

The practice of restoring degraded areas has significantly evolved in Brazil, particularly in the mining sector, targeting native vegetation re-establishment (HONSCHA *et al*., 2021). Despite advancements in restoration techniques and products, its management still faces challenges within companies and the government (STEFANES *et al*., 2018; GASTAUER *et al*., 2019). The lack of public and institutional mechanisms to ensure funding for recovery plans and companies' insufficient allocation of financial resources are contributing factors to unsuccessful restoration projects (YOUNG; CASTRO, 2021; DOCKENDORFF *et al*., 2022).

In response, alternative restoration methodologies, such as native seedling rescue with immediate transplantation, stand out as more practical and economical than traditional methods. It means reducing expenses related to seedling acquisition, transportation, substrates, containers (e.g., tubes), and other costs associated with maintaining plants in nurseries. It also avoids soil layer storage. This approach is particularly beneficial in areas where degradation is not as critical but remains underexplored, especially in the Cerrado biome (SANTOS; MILANI, 2021).

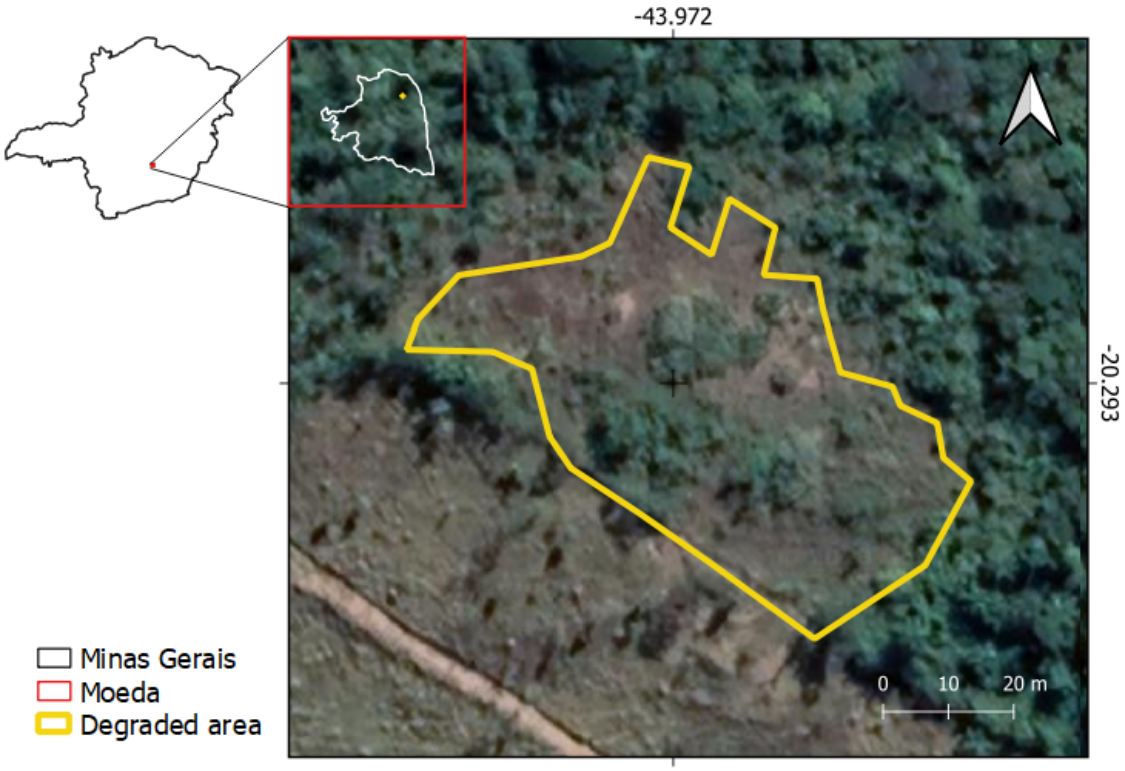
Thus, our study aimed to evaluate the transplantation of rescued seedlings from native individuals for the recovery of a degraded area in Moeda, Minas Gerais. We tested two treatments: with and without hydrogel in the planting holes.

DOI: https://dx.doi.org/10.18066/inic0079.23

Methodology

The experiment was conducted in a 0.5-hectare area located in Moeda, at Fazenda da Estrada Velha (FIGURE 1). Illegal gravel extraction in the 1980s disturbed the site, which has naturally and partially recovered since. As a result, its soil is not entirely exposed. Field efforts aimed to promote reforestation and biodiversity enhancement in the area, reintegrating it into the surrounding landscape.

Figure 1 – Study area.



Source: authors (2023).

We conducted four field visits in 2019:

• January 17th – Area reconnaissance;
• February 9th – Rescue and seedling planting;
• April 21st – Rescue, seedling planting, and monitoring;
• June 20th – Seedling monitoring.

The area has a humid subtropical climate with dry winters, classified as Cwa (Köppen; Geiger, 1936). The average temperature is 20.9°C and the annual average rainfall is 1345 mm (IDE Sisema, 2023). The soil is a medium-texture dystrophic Cambisol associated with rock outcrops, a moderate A horizon, and a stony phase, often associated with strongly undulating terrain (IDE Sisema, 2023). Despite being surrounded by the Floresta Estacional Semidecidual Montana, an Atlantic Forest vegetation type, the area displays typical Cerrado vegetation. The rescue of native seedlings was carried out through random walking near the area, aided by a garden shovel (FIGURE 2).

We immediately transplanted sixty-two individuals after the rescue, divided into two treatments (T), with hydrogel (WH) and without hydrogel (WOH) in the planting hole. Among these, forty seedlings were for reforestation (R), and twenty-two seedlings were for biodiversity enhancement (BE) of the site (TABLE 1).

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Figure 2 – Seedling rescue using a garden shovel.

a) *Solanum lycocarpum*, b) *Guarea* sp., c) *Hymenaea courbaril*.
Source: authors (2019).

Table 1 - Species, treatment (T, in which WH - with hydrogel and WOH - without hydrogel), and number of transplanted seedlings (NTS) per species. Seedlings used for reforestation (R) and biodiversity enhancement (BE) are indicated below.

Species	**T**	**NTS**	
		Feb 9th	**Apr 21st**
Cybistax antisyphilitica (Mart.) Mart.	WH	3	-
Guarea sp.	WH	8	-
Guazuma ulmifolia Lam.	WH	2	-
Melastomataceæ ni 1	WH	1	-
Melastomataceæ ni 2	WH	1	-
Miconia albicans (Sw.) Steud.	WH	2	-
Platypodium elegans Vogel	WH	10	-
Solanum lycocarpum A.St.-Hil.	WH	9	-
Tibouchina granulosa (Desr.) Cogn.	WH	4	-
Acrocomia aculeata (Jacq.) Lodd. ex Mart.	WH	-	10
	WOH	-	9
Hymenaea courbaril L.	WH	-	2
	WOH	-	1
TOTAL		**40 (R)**	**22 (BE)**

Source: authors (2023).

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We used a garden shovel to open all the planting beds at random locations in the area where the soil was exposed. With the help of a wood skewer, we fixed a cardboard square around each transplanted seedling to reduce soil temperature, conserve moisture in the planting bed, and eliminate frequent weeding (FIGURE 3). During monitoring, we recorded the number of surviving seedlings.

Figure 3 – Cardboard fixed with wood skewers around the seedling.

Source: authors (2019).

Results

Results are shown in Table 2.

Table 2 – Species, treatment (T, in which WH - with hydrogel and WOH - without hydrogel), number of transplanted seedlings (NTS), number of surviving seedlings (NSS), and survival percentage (S(%)) per species.

Species	T	NTS	Apr 21st		Jun 20th	
			NSS	S (%)	NSS	S (%)
Cybistax antisyphilitica	WH	3	0	0	0	0
Guarea sp.	WH	8	0	0	0	0
Guazuma ulmifolia	WH	2	0	0	0	0
Melastomataceæ ni 1	WH	1	0	0	0	0
Melastomataceæ ni 2	WH	1	0	0	0	0
Miconia albicans	WH	2	0	0	0	0
Platypodium elegans	WH	10	3	30.0	2	20.0
Solanum lycocarpum	WH	9	2	22.2	1	11.1
Tibouchina granulosa	WH	4	0	0	0	00
Acrocomia aculeata	WH	10	-	-	0	0
	WOH	9	-	-	0	0
Hymenaea courbaril	WH	2	-	-	0	0
	WOH	1	-	-	1	100
TOTAL	-	**62**	**5**	-	**4**	-

Source: authors (2023).

In the last visit to the area, we recorded a survival rate of 6.45% concerning the sixty-two transplanted individuals: *Platypodium elegans* (2), *Solanum lycocarpum* (1), and *Hymenaea courbaril* (1). When considering the number of seedlings for reforestation and biodiversity enhancement separately, we obtained survival rates of 7.5% and 4.5%, respectively. The results for *A. aculeata* and *H. courbaril*, when analyzed separately, indicate that the survival of these species in the area is not related to the

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use of hydrogel in the planting hole. The survival percentage of *H. courbaril* under the WOH treatment was 100%. However, the survival percentage for the total transplanted seedlings was 33.3%.

Discussion

The seedlings were transplanted after the rainy season, which may have negatively impacted their establishment. Planting during the rainy season ensures that seedlings receive adequate water to establish their root systems and cope with potential water stress during the dry season (PEREIRA *et al*., 2021; SANTOS *et al*., 2022). However, the planting holes remained moist during the monitoring period thanks to hydrogel and cardboard.

Another significant factor influencing seedling survival was the presence of ants and armadillos in the area. Ants can harm seedlings by attacking their foliage, leading to defoliation and weakening of the plants (KULIKOWSKI; ZAHAWI; HOLL, 2022). Similarly, armadillos can disturb planting beds, uproot seedlings, and damage young plants. These biotic interactions should be considered in site selection and restoration planning to minimize potential negative impacts on transplanted seedlings (FIGURE 4). At the site, four burrows were discovered.

Figure 4 - Damage caused to seedlings by armadillos and ants in the area.

a) Uprooted seedling, b) Armadillo burrow, c) Disturbed planting bed, d) Seedling defoliation.
Source: authors (2019).

Soil conditions at the site may also have played a crucial role in seedling survival. The study area exhibited shallow and compacted soil conditions, with a rocky phase and lack of a well-developed A horizon. Such soil characteristics can restrict root growth and limit access to nutrients and water, negatively affecting seedling establishment and growth. Conducting soil analyses before undertaking restoration projects to identify potential limitations and select suitable species adapted to the prevailing soil conditions is essential.

Hydrogel may not have provided a significant advantage to seedling survival in this setting. However, it is worth noting that the sample size for *H. courbaril* was relatively small. Further research with a larger sample size is necessary to draw more robust conclusions regarding the hydrogel effect on seedling survival.

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Conclusion

The species with the highest survival rate was *Hymenaea courbaril*. In proportion, reforestation seedlings achieved a higher survival rate than those for biodiversity enhancement. The overall survival rate of all transplanted seedlings until the last visit to the area was 6.45%. When considering the transplantation of rescued native seedlings in natural areas, it's essential to be mindful of the presence of ants and other animals that may impact seedling survival and local soil conditions. The results indicate that the survival of these species in the area is not related to hydrogel use in the planting bed. The use of cardboard around the seedlings proved crucial in maintaining moisture in the planting holes and reducing weeding. We believe that the most effective option for restoring the area in question, considering conservative techniques, is assisted natural regeneration.

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Acknowledgments

We thank UFVJM and CAPES - Brazil (Funding Code 001) for the opportunity to improve this work.

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