ECOLOGICAL RESTAURATION IN TROPICAL MINED LANDS

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Mining generates different environmental impacts

And creates different scenarios...

- Overburden piles

- Road cuts

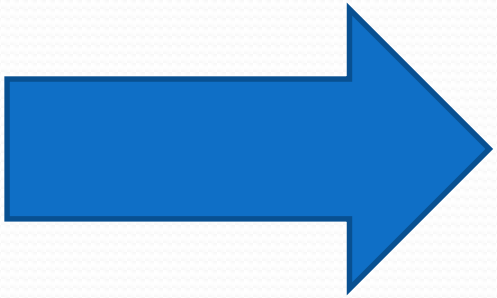
- Tail pounds (tanks)


Spoil

Surface mining

Different environments to reclaim :

- **Slopes**
  - Road cuts
  - Pit mine
  - Overburden dumps
- **Tail ponds**
- **Spoil**



Impacts

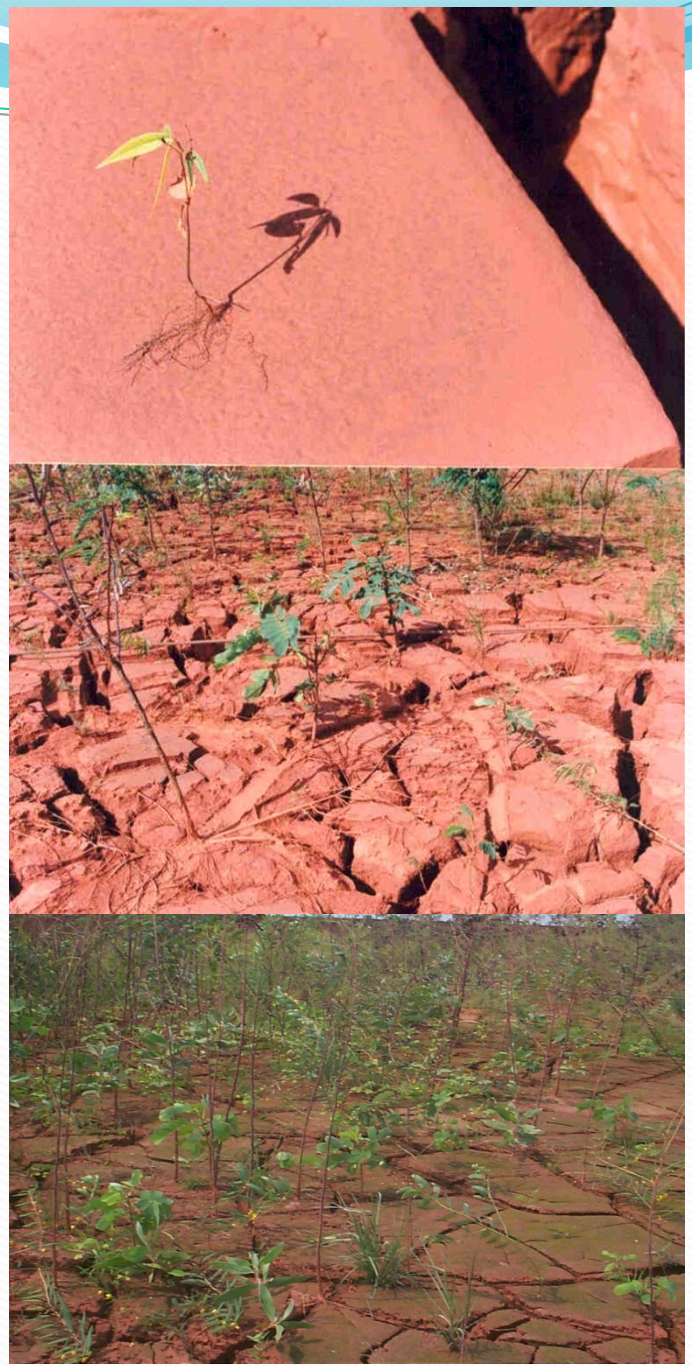
- Suppression of vegetation
- Suppression of fauna
- Soil removal
- Rock exposition
- Change in hydrological systems

Collapse
Destruction of the physical system

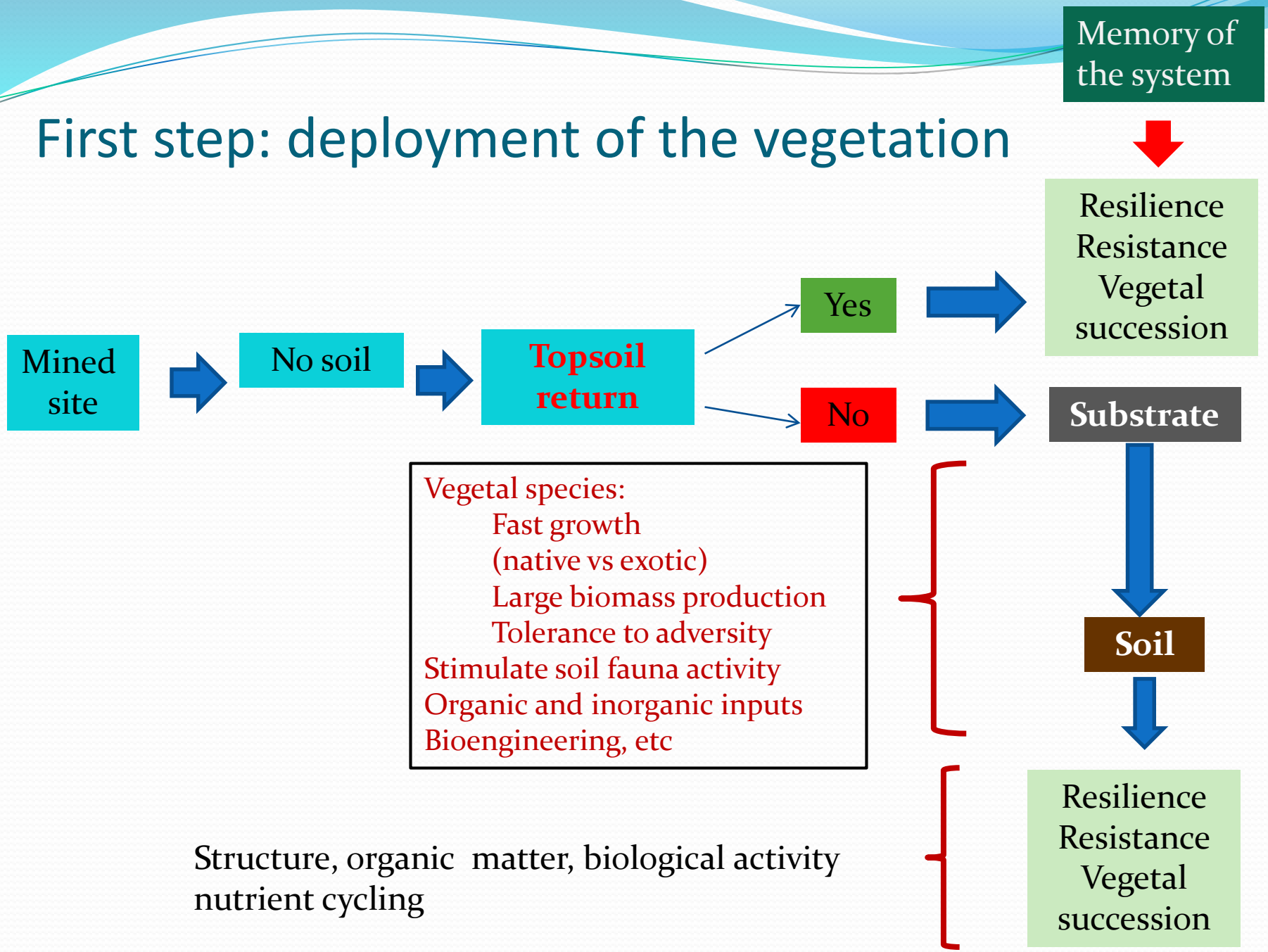
Substrate with unfavorable chemical, physical and biological conditions to plant growth

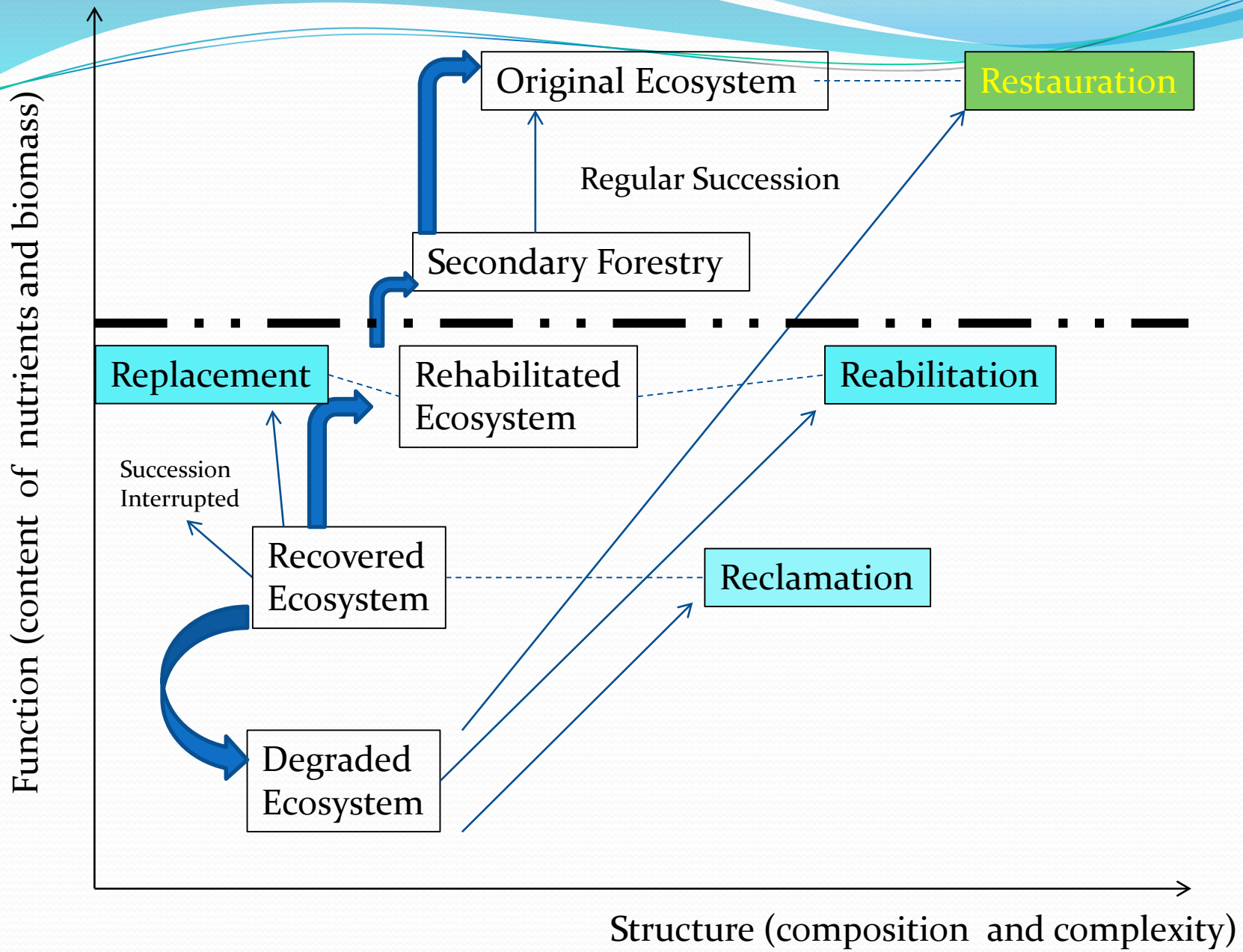
To set a sustainable vegetation system:

- The first step towards the reconstruction of an ecosystem is the restoration of vegetation, because other forms of life depend on this component.
- But sometimes it takes time and something more….



First step: deployment of the vegetation





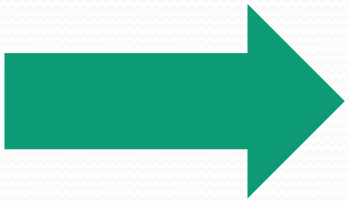
Engel & Parrota, 2003

ECOLOGICAL RESTAURATION (SER, 2004)

- Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.
- Restoration attempts to return an ecosystem to its historic trajectory.
- The historic trajectory of a severely impacted ecosystem may be difficult or impossible to determine with accuracy.

ECOLOGICAL RESTAURATION (SER, 2004)

- An ecosystem has recovered - and is restored – when:
  - It **contains sufficient biotic and abiotic resources** to continue its development **without further assistance or subsidy**.
  - It will sustain itself structurally and functionally.
  - It will demonstrate resilience to normal ranges of environmental stress and disturbance.
  - It will interact with contiguous ecosystems in terms of biotic and abiotic flows and cultural interactions.

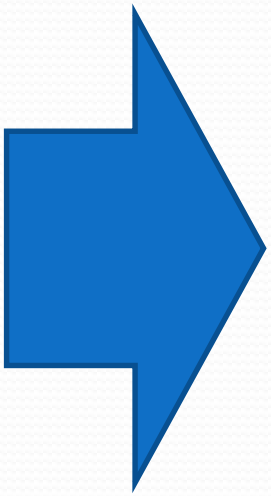


AUTOSSUSTENTABILIY

Procedures for environmental restoration

- Should be assessed for environmental hazards, future use of the area, harmonizing with the surrounding environment and sustainability of the system

- Include biodiversity with emphasis on local and regional species trying to follow the historical trajectory of the ecosystem



Ecological restoration

Procedures that promote the ecological restoration of degraded mining areas

- Topsoil return;
- Use species that facilitate the succession process;
- Nucleation:
  - Litter
  - Crop residues
  - Perches, etc

Topsoil return

Topsoil return

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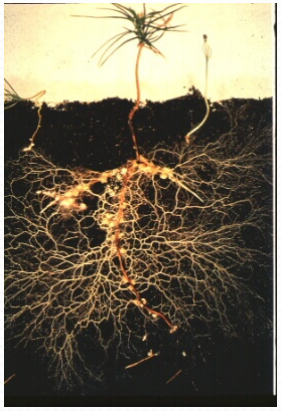
Species that facilitate the succession process

Diazotrophic bacteria (saprophytic)

mycorrhizal fungus (biotrophic required)



Plants nodulated and mycorrhized
(Fix C and N, more efficient in absorbing water and nutrients and tolerance to environmental stresses)

Advantages of accumulated leguminous plants when in symbiosis with diazotrophic bacteria and mycorrhizal fungi to grow on substrates deprived of organic matter and subject to environmental stresses.

Species that facilitate the succession process

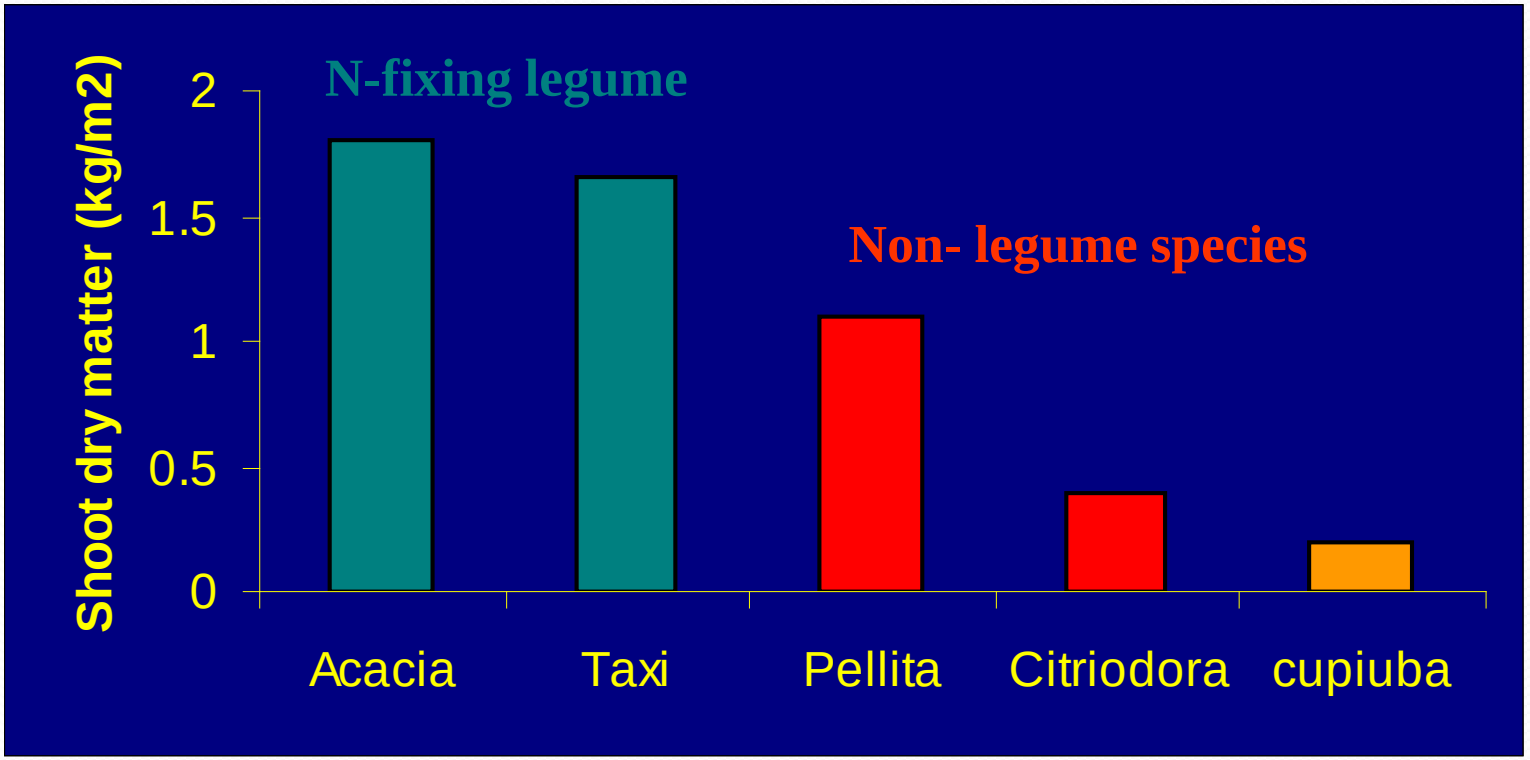
- High biomass production;
- Fast grown;
- More input of N and organic matter to soil;
- More OM means improving in soil structure, porosity and water hold capacity;
- Create better environment to recruited or spontaneous species;

Species that facilitate the succession process

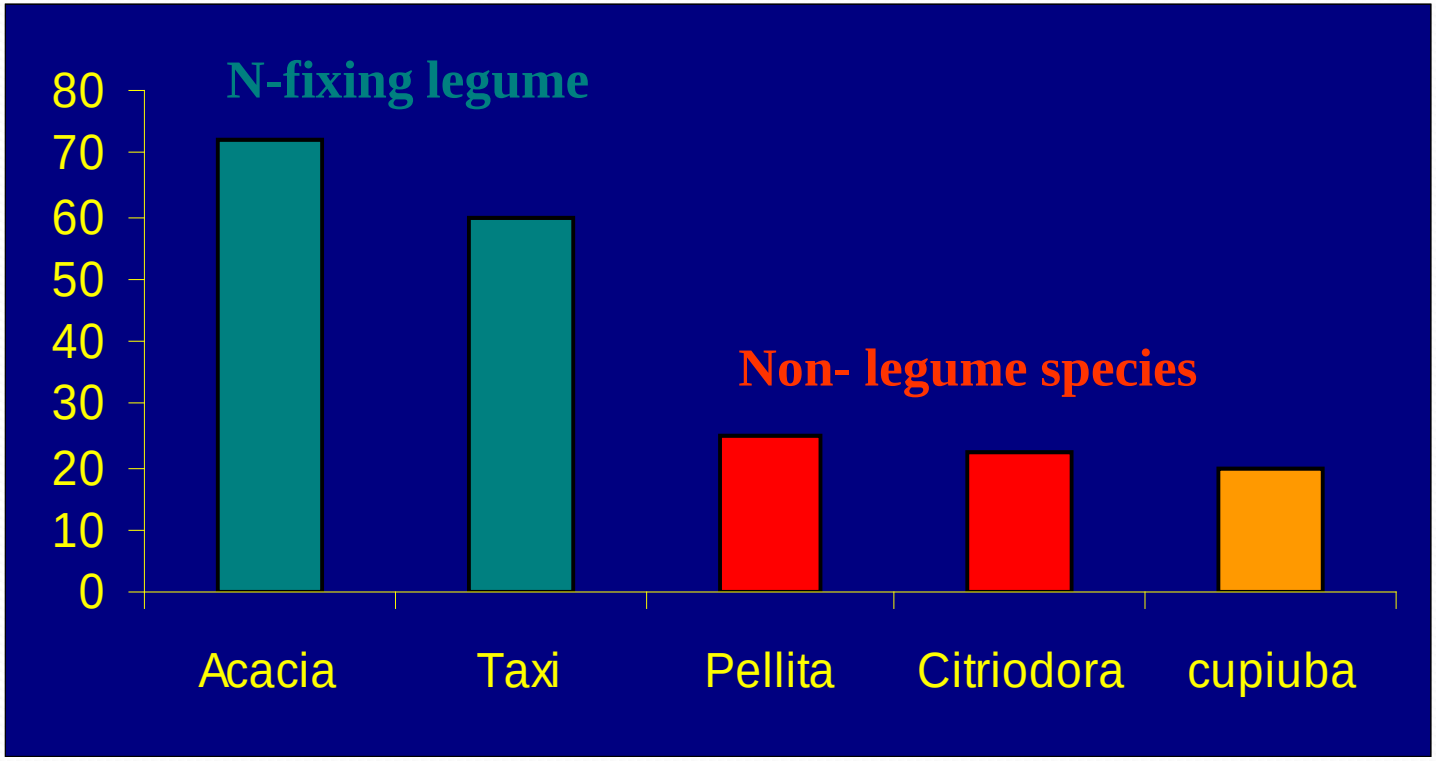
- **Local:**
  Para State, Amazon Region
  Borrow area– Oxissol

- **Revegetation:**
  - N-fixing legume species: *Acacia mangium* e *Tachigali vulgaris*
  - Non-legume species: *Eucalyptus pellita e C. citriodora*
  - Non-fixing legume species: *Goupia glabra* (cupiúba)

- **Evaluation:**
  11 years after revegetation.



Shoot dry matter of natural regeneration species growing in Legumes and Non-legumes species plots.



Number of species from natural regeneration growing in Legumes and Non-legumes species plots.

- Revegetation in non consolidated bauxite tailing pond using hydrosseding with seeds Leguminous species

Clay	Silte	Sand	O.M.	P	K	Al^{3+}	Ca^{2+}	Mg^{2+}	H+Al	pH
---------- % ----------				- mg dm^{-3}		--------- $cmol_c$ dm^3 ----				
77	22	1	0.02	0.1	1.0	0	0.05	0.00	1.33	4.9

Fast growth and high humidity tolerant

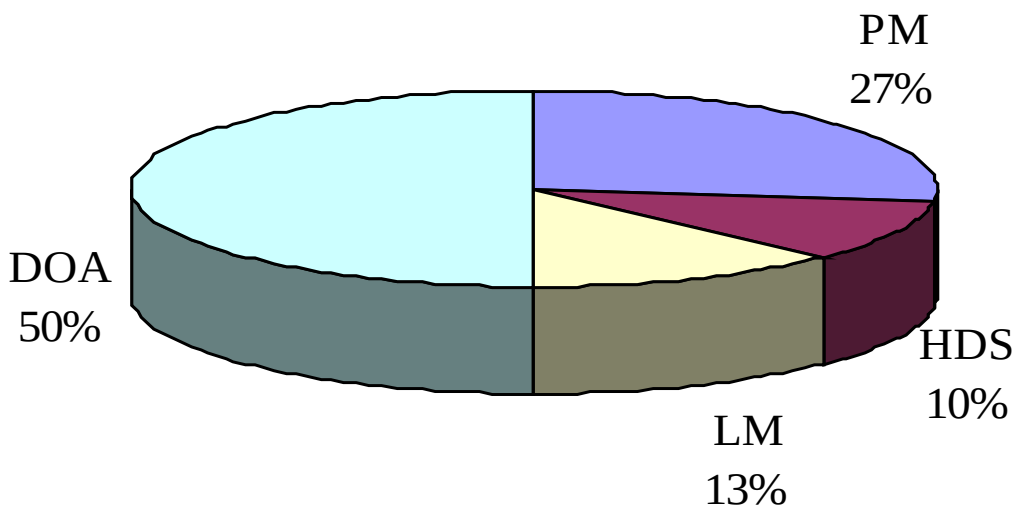
Sesbania virgata
Sesbania exasperata
Senna occidentalis
Senna reticulata
Acosmium nitens

Acacia holosericea
Chaemacrista flexuosa
Sclerolobium paniculatum
Aeschynomene sensitive
others

Hydrosseding

Six months after hydrosseding

Five years after the hydrosseding



Distribution of the total of sampled species for the different arrival forms in the area. PM - planting for seedlings;

LM - manual release of seeds;

HDS - hydroseeding;

DOA - dispersion of other areas.

Procedures that promote the ecological restoration of degraded mining areas

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Nucleation with litter

Nucleation with litter

Enrichment of the litter with seeds of species of ecological interest

Facilitators
Fruit
Rare
Etc.

Using litter and seed bank to starts revegetation process in an bauxite tail tank

Three year after litter application

Iron mining in Minas Gerais State & Ferruginous-altitude grassland ecosystems

The substrate of “canga” (ironstones outcrops)

Restrictions on the establishment of plant species

-Shallow soils;
-Low moisture and nutrients;
-Poor structure;
- Large daily temperature range;

Flora: The high specialization of vegetation contributes to the high rate of endemism.

Área de resgate

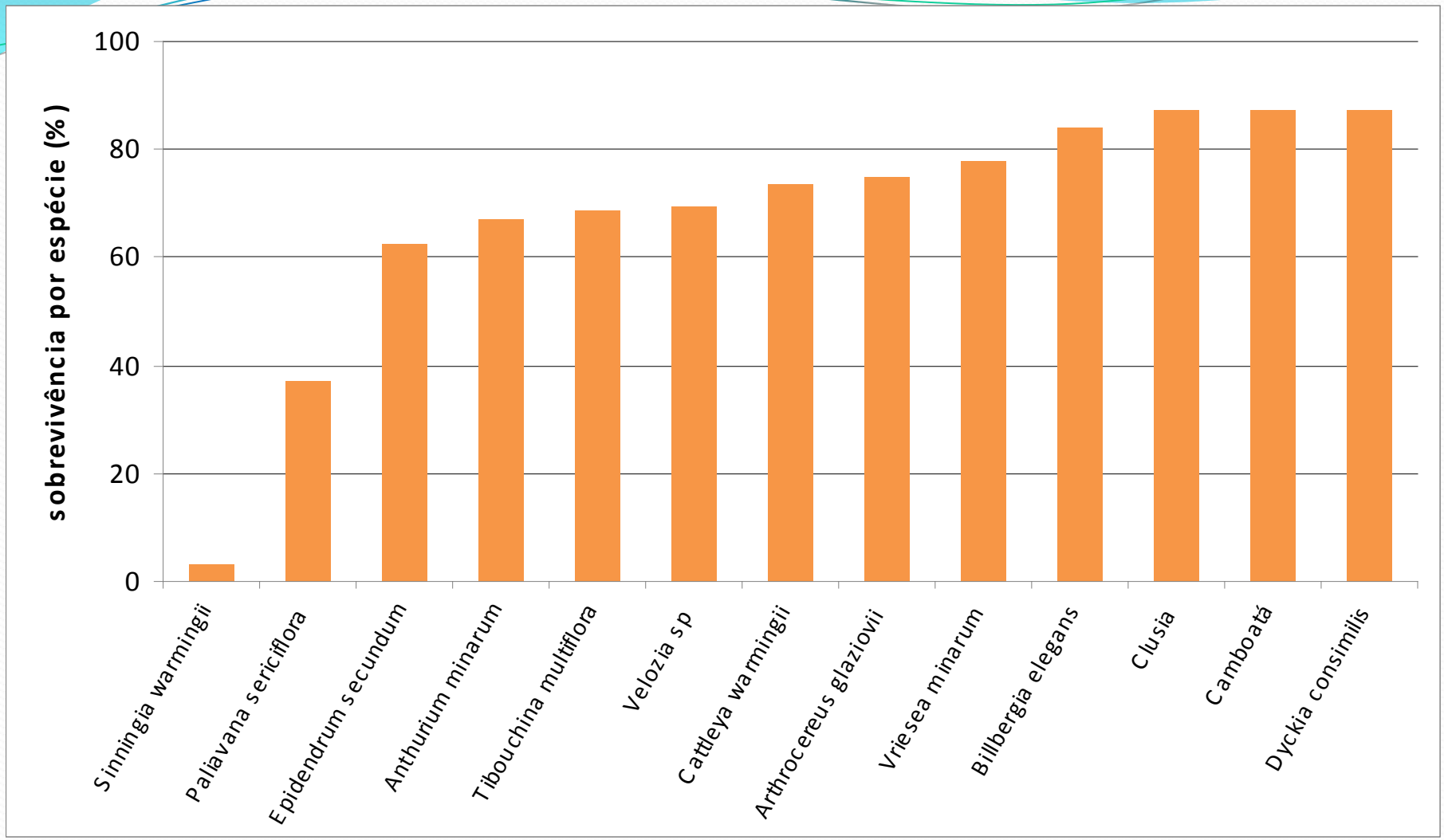
Área de reintrodução

Reposição do material sobre uma pilha de estéril

Fontes de variação:

- Duas espessura do material de canga (20 e 40 cm)
- Quatro níveis de adubação (0; 0,3; 0,6 e 1,0)

Plantas do resgate enviveiradas para posterior reintrodução



Taxa de sobrevivência das espécies aos 11 meses após o plantio

Das espécies testadas, 73 % apresentou índice de sobrevivência > 69 %

Avaliação regeneração aos 11 meses após o plantio.

A técnica de reconstrução com materiais de campos ferruginosos permite o ingresso de espécies que apresentam baixos índices de sobrevivência ao resgate, assegurando a preservação da diversidade biológica e genética de muitas espécies.

Mimosa calodendron

Stachytarpheta glabra

Portulaca hirsutissima

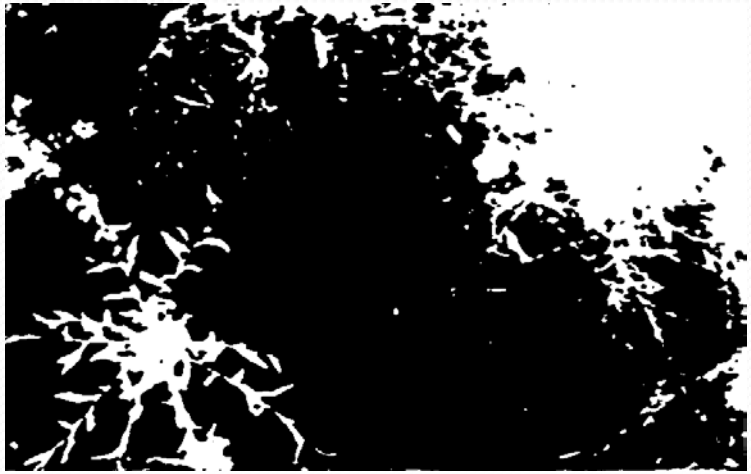
Calibrachoa elegans

Na regeneração natural: espécies ameaçadas de extinção da flora de Minas Gerais

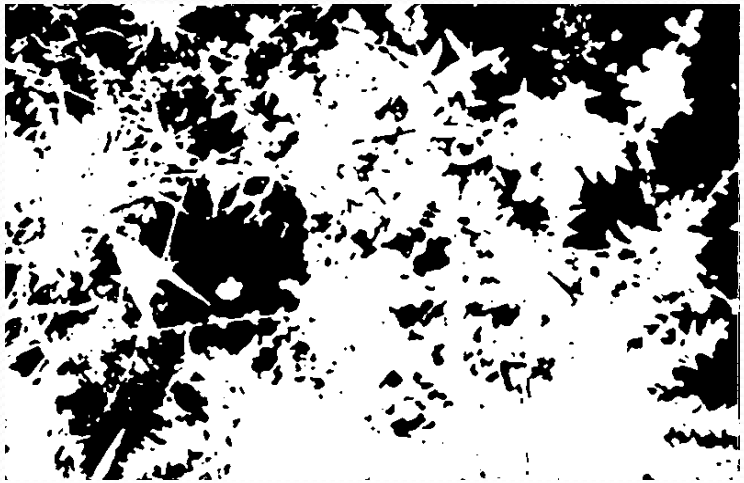
Sinningia rupicola

A aplicação de camada de 40 cm de material de canga proporcionou maior índice de cobertura vegetal, conferido especialmente pelas espécies provenientes da regeneração natural

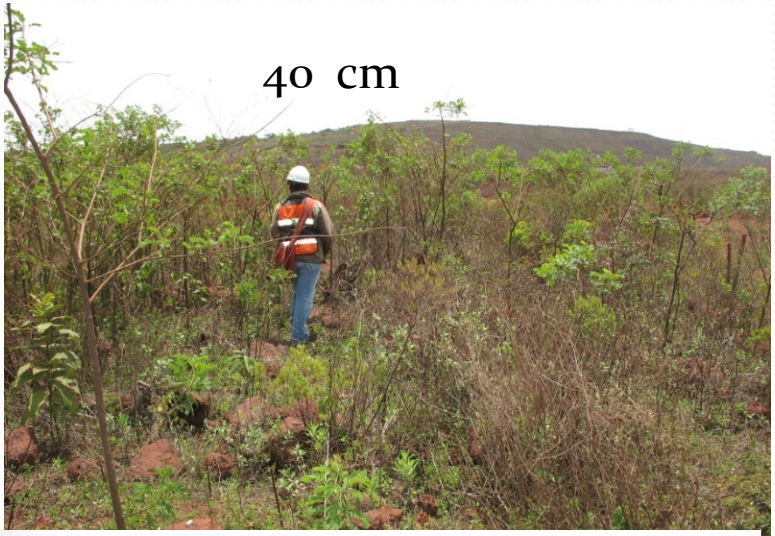
20 cm

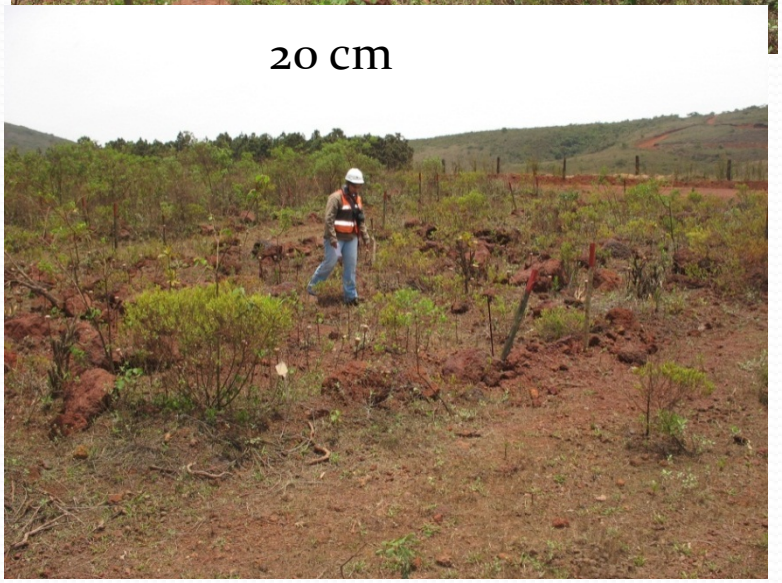


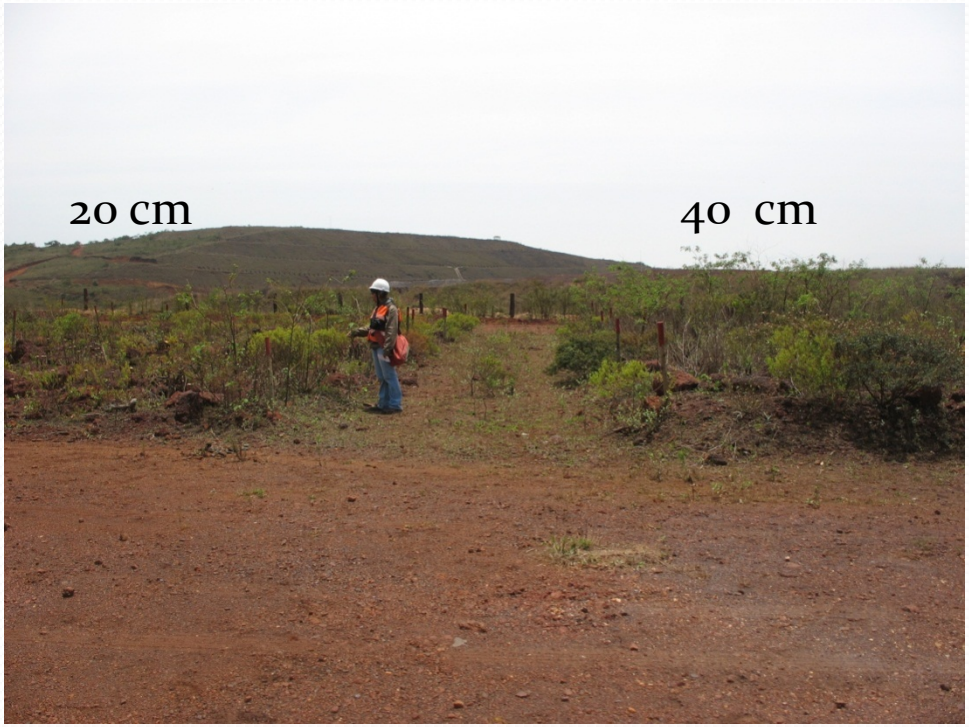
40 cm



As diferentes espessuras favoreceram o desenvolvimento de diferentes arranjos ambientais estabelecendo uma situação de mosaico muito comum nos campos naturais.







Visão parcial da área experimental ao 34 meses após o plantio


40 cm
20 cm

Final considerations

- Ecological restoration is not incompatible with areas drastically altered by mining activities;
- The use of different approaches that emphasize the formation of a new soil is the foundation that will ensure the journey toward self-sustainability of the environment.
- The use of non-native legume species to facilitate the succession process can be a fundamental approach to ecological restoration of drastically altered areas by mining activities.