

Metais Pesados como Barreiras Invisíveis a Agricultura Regenerativa

Luis Fernando Guimaraes Vidal

Agronomy Student - Uniasselvi

ORCID: <https://orcid.org/0009-0005-9507-4436>

Abstract

Regenerative agriculture aims to restore living soils through the addition of beneficial microbiota and sustainable practices. However, many systems show lower than expected productivity, even with technically appropriate application. This article proposes that heavy metal contamination is a critical and overlooked factor, acting as an invisible barrier to soil microbiology. The use of cover crops with phytoremediation capacity is proposed as an accessible and viable solution in Brazil.

1. Introduction

Regenerative agriculture has gained ground in Brazil as a sustainable alternative to conventional agriculture, proposing the restoration of soil life through the addition of beneficial microbiota, composting, and agroecological practices. However, even with these practices, many farms report low productivity, raising questions about invisible limiting factors, such as the presence of heavy metals. This contamination may inhibit the action of introduced microorganisms, nullifying the expected benefits.

2. Scientific Foundation

Several studies confirm that soil microorganisms are highly sensitive to the presence of heavy metals such as aluminum, cadmium, lead, mercury, nickel, and

copper. These elements, even at relatively low concentrations, affect microbial respiration, nitrogen fixation, and enzymatic activity. The soil, like the human intestine, needs a detoxified environment so that probiotics and beneficial organisms can act effectively. Therefore, regenerating soil without detoxifying it is like treating gut flora without first removing heavy metals from the body.

3. Proposed Solution

A preliminary step to regeneration is proposed: phytoremediation with plants capable of absorbing or immobilizing heavy metals. These species can be used as cover crops, with appropriate management to maximize their extraction and detoxification capacity.

Table 1 - Phytoremediating Plants

Hemp (*Cannabis sativa*) - Capacity: High for Cd, Pb, Ni, Zn, Advantages: High biomass, fast growth, Feasible in Brazil: Legally restricted

Sunflower (*Helianthus annuus*) - Capacity: High for Pb, Zn, Cu, Advantages: Easy cultivation, already widespread, Feasible in Brazil: Yes

Crotalaria (*Crotalaria juncea*) - Capacity: Good for Cu, Zn, Cd, Advantages: Nitrogen-fixing, nematode control, Feasible in Brazil: Yes

Castor bean (*Ricinus communis*) - Capacity: High for Cd, Pb, Advantages: Drought tolerant, Feasible in Brazil: Yes

Indian mustard (*Brassica juncea*) - Capacity: High for various metals, Advantages: Good biomass, Feasible in Brazil: Yes

Marigold (*Tagetes erecta*) - Capacity: Moderate, synergistic support, Advantages: Natural repellent, Feasible in Brazil: Yes

4. Regenerative Management Protocol

1. Conduct soil analysis focusing on heavy metals.
2. Implement selected phytoremediation plants for 1 to 3 cycles.
3. Cut and incorporate the biomass into the soil.
4. Add biochar, worm humus, and effective microorganisms (EM).
5. Only after this process, apply regenerative microbiota.
6. Monitor through chemical analysis and biological soil indicators.

5. Discussion

Most regenerative projects fail by ignoring the accumulated toxicity in soils. The belief that simply adding biology restores the soil is simplistic and counterproductive. Considering the soil as a living and intoxicated organism expands the possibilities of success, especially in tropical soils affected by decades of intensive use and diffuse pollution. Tropical phytoremediation plants offer a practical, accessible, and scientifically valid solution.

6. Conclusion

True soil regeneration begins with detoxification. Regenerative agriculture must consider phytoremediation as a fundamental step, especially in soils with a history of intensive use or proximity to urban areas. By integrating this practice into management, the productive potential and effectiveness of applied microbiota are expanded.

7. References

- Pilon-Smits, E. (2005). Phytoremediation. Annual Review of Plant Biology.
- Glick, B. R. (2003). Phytoremediation: synergistic use of plants and bacteria.

Biotechnology Advances.

- Lima, J. M. et al. (2019). Soil microbiology and fertility under different management systems. Embrapa.
- Souza et al. (2021). Phytoremediation potential of crotalaria. Brazilian Journal of Agroecology.

8. License

This work is licensed under the terms of the Creative Commons Attribution 4.0 International (CC BY 4.0).

You are free to share, copy, redistribute and adapt the material in any medium or format, for any purpose, even commercially, as long as proper credit is given to the original author.

For more information, visit: <https://creativecommons.org/licenses/by/4.0/>