

Carbon Sequestration by and for North-South Slopes Symbiosis of Biochar and Rock Dust Applications

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Executive summary. New arable land formed by North-South slopes can become a long-term carbon sink if soil building is designed into the cultivation system from the outset. This draft proposes a coupled approach in which biochar production, biomass cultivation, and carbon-enriched rock dust application reinforce one another. Biomass grown on a designated portion of the new arable land can supply modular pyrolysis systems located near the fields. The resulting biochar can be incorporated into

soils to improve carbon retention, moisture holding, and soil physical condition, while the process heat and power from pyrolysis can support rock crushing and conditioning. In this way, the waste stream of one process becomes a productive input to another, creating a practical circular-economy model for semiarid land development.



Figure 1. Illustrative North-South slope cultivation system with tree rows and cropped bands.

1. Introduction

Cultivated agricultural soils accumulate organic matter through repeated inputs of crop residues, roots, and other biological material. By contrast, semiarid marginal land that has not been cultivated may contain limited organic carbon and weak soil structure. For that reason, newly created arable land associated with the North-South slope concept should be viewed not only as a food-production platform, but also as an opportunity for deliberate soil-carbon formation.

This paper develops a practical carbon-sequestration strategy for such land. The central idea is to couple two soil-amendment pathways - biochar and carbon-enriched rock dust - so that each supports the other technically and economically. The result is a system that can improve soil quality, increase biomass

productivity, and lock atmospheric carbon into soils over extended periods.

2. Biochar pathway for long-term carbon storage

Biochar is a carbon-rich solid produced by pyrolysis of biomass under oxygen-limited conditions. Suitable feedstocks include wood chips, crop residues, wheat straw, corn husks, and residual materials from agricultural processing. Because a significant fraction of the carbon in the original biomass is converted into stable char, the process can retain carbon in soils for very long periods after field application.

In addition to carbon storage, biochar can improve several soil properties relevant to semiarid cultivation. It can enhance water-holding capacity, improve aggregation and porosity, moderate nutrient losses, and support better rooting conditions. These agronomic effects are important because they help transform the

new slope-generated land from a mechanically created surface into a biologically productive soil system.

Pyrolysis also produces combustible volatiles and gases. Rather than treating these only as emissions to be destroyed, the process can be engineered so that secondary combustion generates usable thermal energy and electric power. That recovered energy can be used productively for drying incoming biomass, improving feedstock preparation, and serving nearby industrial processes associated with land development.

3. Biomass supply from the new arable land

A major constraint on wide-scale biochar deployment for extensive agriculture is feedstock availability. The North-South slope system offers a way to address that constraint directly. A designated fraction of the newly created arable land can be planted with fast-growing, low-canopy woody species or other

rapidly regenerating biomass crops such as poplar or cottonwood. These plants capture atmospheric carbon through photosynthesis and provide a renewable local feedstock for modular pyrolysis units.

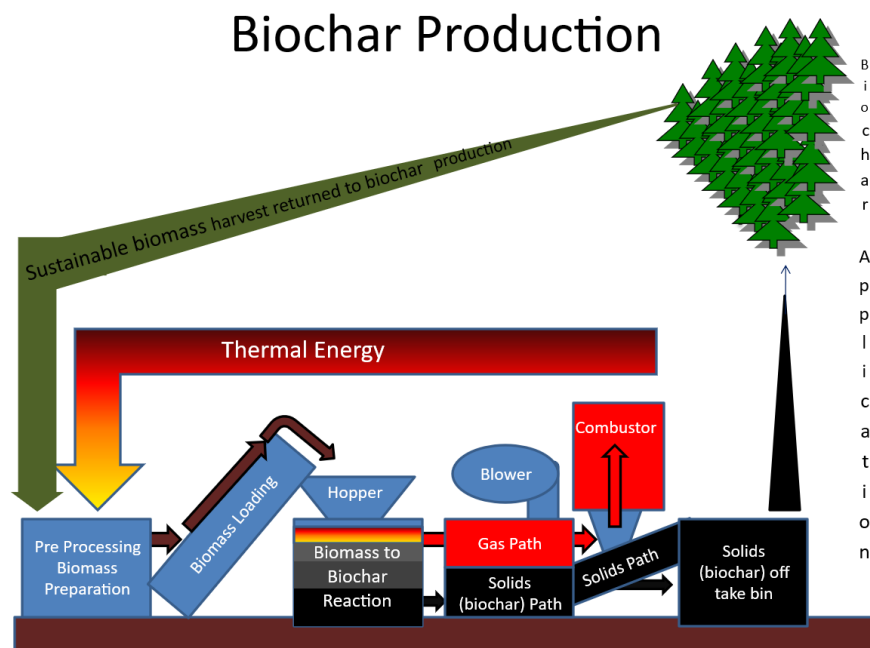


Figure 2. Schematic representation of biochar production and associated energy recovery.

Locating pyrolysis systems close to the cultivated slopes reduces transport, handling, and storage burdens. It also allows

the biochar to be returned quickly to the same production landscape from which the biomass originated, creating a closed-loop soil-building cycle. Over time, part of the carbon fixed by the vegetation is harvested, stabilized as char, and reincorporated into the agricultural soil base.

4. Carbon-enriched rock dust as a complementary amendment

A second promising pathway for soil improvement is the application of finely crushed rock dust enriched with carbon ([Beerling](#).)

Enhanced rock weathering has been proposed as a way to address climate, food, and soil-security challenges, and the concept is especially relevant where newly formed soils require mineral amendment as well as organic enrichment. In the present context, rock dust is not viewed as a substitute for biochar, but as

a complementary input that can be integrated into the same field-development system.

The carbon associated with the rock-dust pathway could be supplied from several sources: captured carbon from pyrolysis-related gas streams, direct atmospheric capture in future implementations, or carbon captured from stationary power sources and transported to combined processing sites. The production of reactive crushed rock, however, requires substantial mechanical energy for crushing and pulverization and may also require heat for feedstock conditioning. These needs make it a natural partner for an energy-producing pyrolysis installation.

5. Biochar-rock dust symbiosis

The proposed system is intentionally symbiotic. Biochar production supplies a durable soil-carbon amendment while also

generating heat and electric power as by-products. Rock crushing requires exactly those energy inputs. By collocating the two operations, the recovered energy from pyrolysis can be directed into rock processing, lowering the external energy demand of the mineral-amendment pathway.

Conversely, the rock-dust pathway complements biochar by contributing mineral surfaces and weathering capacity that may improve nutrient dynamics and longer-term soil development. Together, the two amendments can help create soils that are not only more carbon rich, but also more resilient, more productive, and better suited to sustained cultivation in semiarid environments.

This arrangement is a strong example of industrial ecology or circular economy: the output stream of one process becomes an input stream for another. In the ReSlope context, the land itself

produces biomass, the biomass feeds pyrolysis, pyrolysis produces biochar plus usable energy, and that energy supports mineral amendment for the same landscape.



Figure 3. Example of revegetation and land improvement (on right side) associated with biochar-based restoration.

6. Expected project benefits

- Long-term sequestration of part of the carbon captured by biomass grown on the new arable land.
- Improved soil physical properties, including moisture retention, aggregation, and biomass-carrying capacity.

- Support for revegetation and for more durable crop production in semiarid conditions.
- Productive use of pyrolysis heat and power for feedstock drying and rock processing.
- A modular system architecture that can be deployed close to the cultivated fields and scaled over time.

7. Conclusion

The North-South slope concept creates an opportunity to form new arable land in semiarid regions. To maximize the long-term value of that land, carbon management should be built into the development strategy from the beginning. A combined biochar and carbon-enriched rock-dust program can do more than offset emissions: it can help create fertile soil, strengthen water relations, improve vegetation establishment, and convert the new landscape into a durable carbon sink. The proposed

integration of biomass cultivation, modular pyrolysis, and rock processing is therefore both a sequestration strategy and a land-development strategy.

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