Green Roads Webinar Series | EPISODE 20

Thursday
27 February 2025

2:00-3:00 p.m.
Manila time (GMT+8)

ADB

BIOENGINEERING FOR GREEN ROADS

Discover practical, cost-effective bioengineering solutions for advancing climate-resilient and eco-friendly transport infrastructure in emerging economies.

REGISTER NOW

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KALYAN THAPA

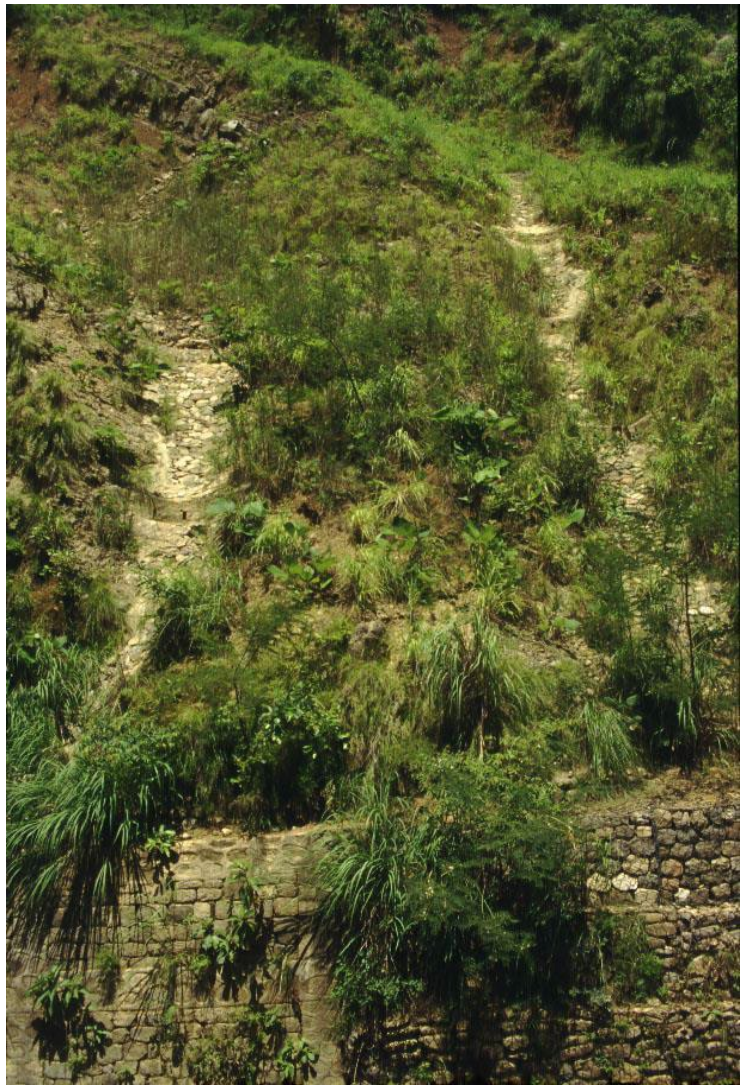
BIOENGINEERING CONSULTANT, AND
GROUNDS MANAGER AT
TRINITY WESTERN UNIVERSITY

Co-organized with: IRF GLOBAL, META META

OVERVIEW AND KEY THEMES

How Bioengineering Enhances Climate Resilience, Water Management, and Biodiversity

- **Climate Resilience:** Enhancing road infrastructure to withstand extreme weather events like floods, landslides, and temperature fluctuations.
- **Water & Land Management:** Implementing sustainable practices to improve water management, reduce runoff, and prevent soil erosion.
- **Biodiversity:** Promoting ecological balance by integrating native plants and fostering biodiversity through bioengineering.
- **Practical Solutions:** Cost-effective, nature-based bioengineering techniques for sustainable and climate-resilient road construction.



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ADVANCING UN-SDGs THROUGH BIOENGINEERING IN ROAD INFRASTRUCTURES

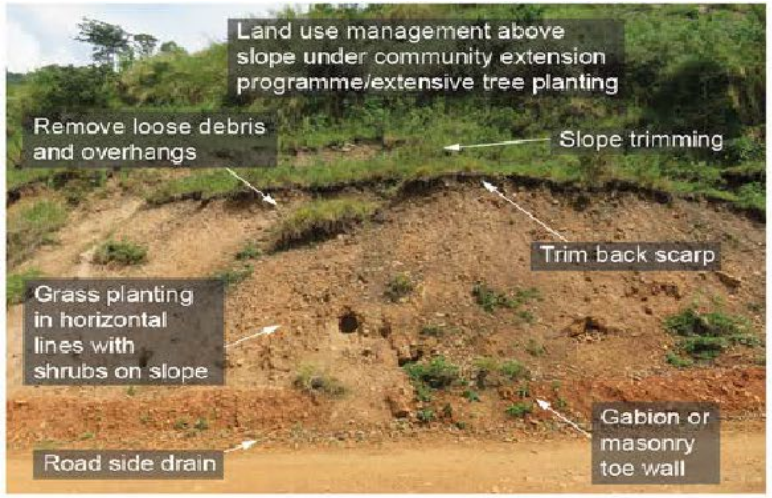
United Nations Sustainable Development Goals highlighting the needs and opportunities associated with Bioengineering (*Image copied from report Sustainability 2021 by Slobodan B Mickovski)*

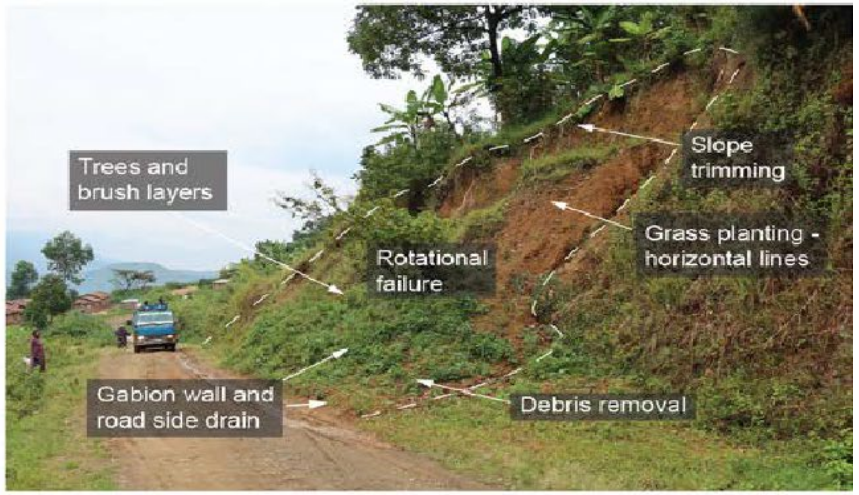
CLIMATE RISKS IN GREEN ROAD INFRASTRUCTURE

Identifying Climate-Related Risks: Flooding, Landslides, and Gully Erosion in Road Infrastructure

EROSION IMPACT ON GREEN ROADS

Photos illustrating effective measures for erosion control and slope management





BIO-ENGINEERING FOR SLOPE STABILIZATION AND EROSION CONTROL: “Sustainable Solutions for a Resilient Future"

What is Bio-Engineering?

The use of living materials (e.g., plants) and natural processes to address engineering challenges like slope stabilization and erosion control.

Why Bioengineering Matters

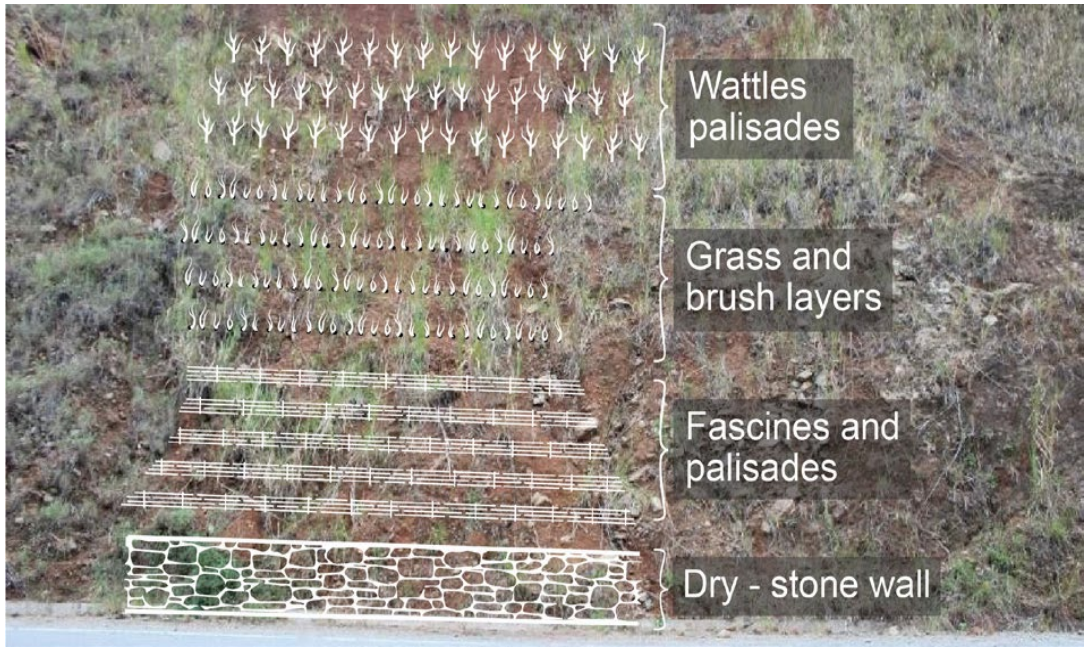
Bioengineering is critical for slope stabilization, erosion control, and ecosystem restoration, offering sustainable solutions to environmental challenges.

Global Applications of Bioengineering

From Southeast Asia to the Pacific Islands, Europe, and North America, bioengineering is used worldwide to address environmental challenges sustainably.

Proven Techniques for Success

Tested and implemented globally, bioengineering techniques are combined with traditional hard engineering to deliver optimal, sustainable results.



BENEFITS OF BIOENGINEERING

WHY BIOENGINEERING?

Environmental Benefits	Economic Benefit	Social Benefits
Biodiversity Enhancement	Cost-Effective Solutions	Community Involvement
Reducing CO_2	Reduced Maintenance Costs	Improved Livelihoods
Habitat Restoration	Long-Term Sustainability	Enhanced Resilience

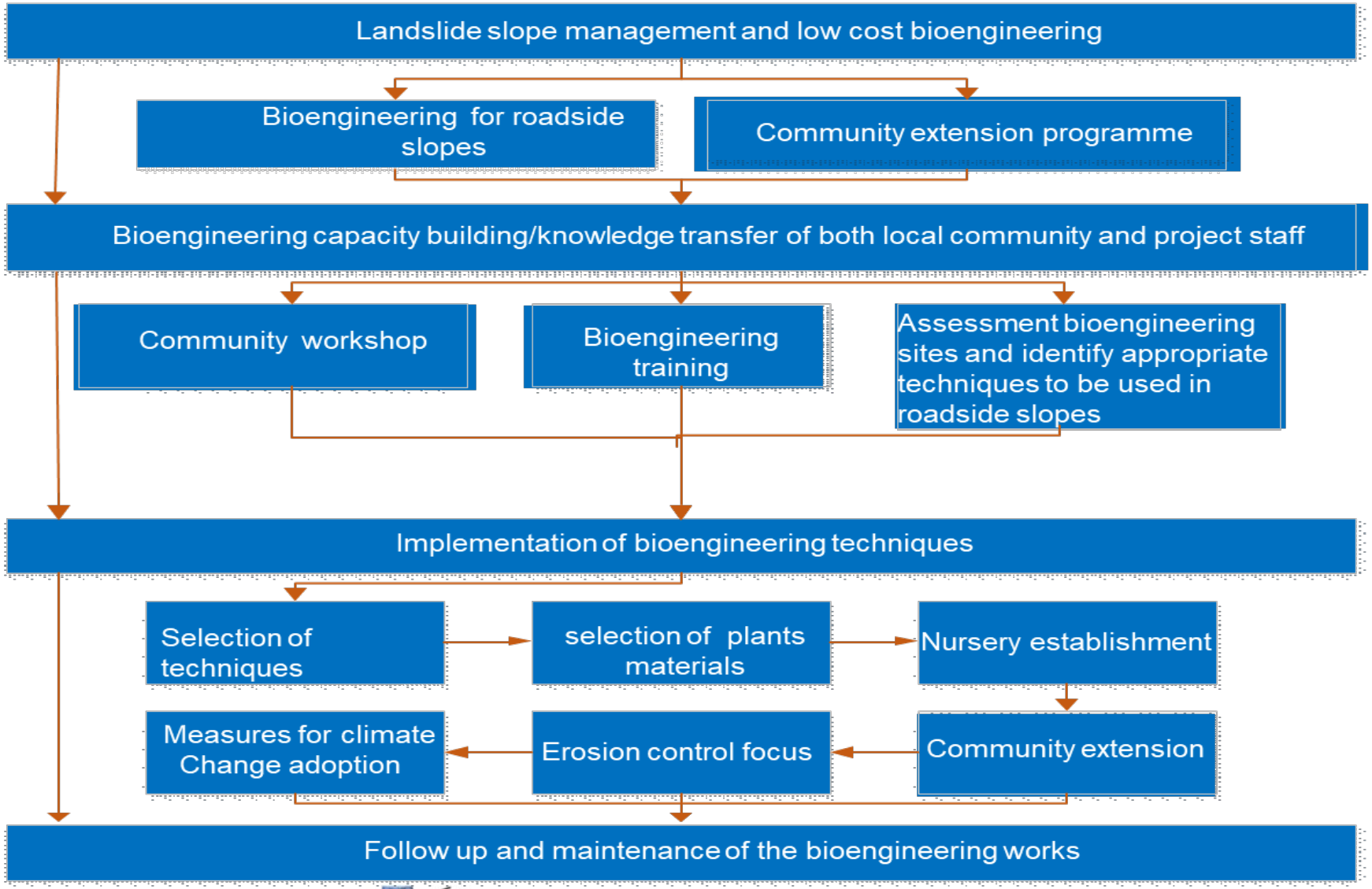
EFFECTIVENESS OF BIOENGINEERING PRACTICES

"How nature-based solutions can prevent erosion and stabilize slopes effectively.“ (Nepal, 1986 -2002)

Photo 1: Landslide
Cut-and-fill practices caused landslides and erosion.
Photos 2-5:
Photo 2: Stone dams
- Stone check dams for water flow management.
Photo 3: Dry pitching
- Dry stone pitching and grass planting for erosion control.
Photo 4: Nurseries
Community-driven plant nurseries.
-Photo 5: Grass planting
Grass planting adapted to slope conditions.

Key Takeaways
- Early nature-based solutions.
- Local resources and indigenous knowledge.
- Zero carbon footprint.

THE BIOENGINEERING PROCESS FOR ROADSIDE SLOPE MANAGEMENT



CASE STUDIES AND BEST PRACTICES OF BIOENGINEERING

Case Study-1: Roadside Slope Rehabilitation in Nepal –Combating Landslides with Bioengineering

Challenge:

Frequent landslides and severe soil erosion in mountainous regions threatened a major highway, disrupting transportation and endangering communities.

Solution:

Labor-intensive grass planting in horizontal lines, combined with other bioengineering techniques such as brush layering and live check dams, was implemented to stabilize slopes.

Outcome:

The project successfully reduced erosion, improved slope stability, and enhanced community resilience. Local communities were actively involved, creating a sense of ownership and long-term sustainability.

CASE STUDIES AND BEST PRACTICES OF BIOENGINEERING

Case Study-2: Roadside Slope Rehabilitation in Northern Laos – Combating Landslides with Bioengineering

Challenge:

Frequent landslides and severe soil erosion in the mountainous regions of Northern Laos threatened a major highway, disrupting transportation, endangering communities, and impacting local livelihoods.

Solution:

Labor-intensive grass planting in horizontal lines, combined with bioengineering techniques such as brush layering, live check dams, and vetiver grass planting, was implemented to stabilize slopes and prevent erosion

Outcome:

The project successfully reduced erosion by 50%, improved slope stability, and enhanced community resilience. Local communities were actively involved in the implementation and maintenance.

CASE STUDIES AND BEST PRACTICES OF BIOENGINEERING

Case Study-3: Roadside Slope Rehabilitation in the Chittagong Hill Tracts Project, Bangladesh – Combating Landslides through Bioengineering (2020-2021)

Challenges:

Fill bags are ineffective and non-durable, failing to address long-term erosion and weathering on rural roadside slopes.

Recommended Solutions:

Replace fill bags with bioengineering measures like vegetative stabilization, live drains ,brush layers and trees planting for permanent slope stability and ecological benefits.

Expected Outcomes:

Long-term slope stability, reduced maintenance costs, improved biodiversity, and community engagement, ensuring sustainable and resilient outcomes.

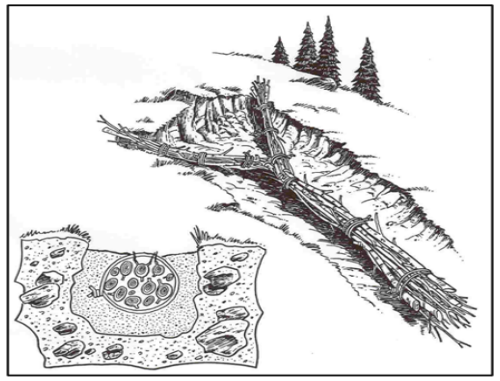


Figure 1. The view shows the layout of live pole drains in a slump with the covering soils removed for clarity. The section shows a typical covering. (Polster, 2003).

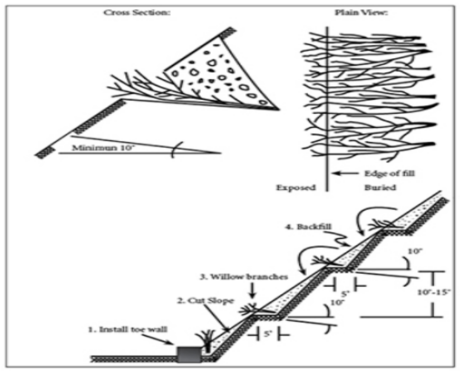


Figure 2. Installation of brush layering. Numbered sequence of operations is shown. Vertical spacing depends on slope angle. (From Gray and Leiser, 1982)

CASE STUDIES AND BEST PRACTICES OF BIOENGINEERING

Case Study-4: Use of Bioengineering for Sloping Land Management in DPR Korea

The SLDM Program (2015-2020) in DPR Korea used agroforestry and bioengineering to address slope erosion and food security. Before implementation, sites showed severe erosion and bare slopes. After the program, terraced slopes, vegetation cover, and stabilized land are visible, demonstrating improved soil fertility and sustainable land use. Pictures highlight the transformation from degraded to restored landscapes, showcasing the program's success.

CASE STUDIES AND BEST PRACTICES OF BIOENGINEERING

Case Study-5: Use of Bioengineering for Sloping Land Management in DPR Korea

Challenge:
Rural populations in DPR Korea faced food insecurity and land degradation due to severe erosion on sloping lands.

Solution:

- Introduced Bio-engineering for erosion control, reforestation, and conservation farming to address food security.
- Reduced disaster risk through Soil Bio-engineering and low-cost techniques via Sloping Land Users Groups (SLUGs).
- Strengthened national DRR capacity through training, seminars,
- study tours, and the development of guidelines and handbooks.

Outcome:

- Improved food security through sustainable land use.
- Enhanced slope and riverbank stability with eco-friendly, low-cost methods.
- Strengthened national DRR capacity and established a scalable
- model for land management and disaster resilience.

CASE STUDIES AND BEST PRACTICES OF BIOENGINEERING

Case Study-6: Mining Land Reclamation through Bioengineering- Teck Cominco's lead-zinc smelter in Trail, British Columbia (2007-2015)

Challenges:
A site near had decades of industrial damage, including bricks, slag, and metal debris. Past re-vegetation efforts failed, leaving the area eroded and ecologically degraded.

Solution:
Soil bioengineering techniques were used to stabilize the hillside and riverbank. These methods established vegetation, reduced erosion, and improved habitat for wildlife and fish.

Outcomes:
The project restored the area, cutting erosion and boosting ecological health. It proved bioengineering's value in mining reclamation, supporting sustainable restoration and setting a benchmark for future projects.

CASE STUDIES AND BEST PRACTICES OF BIOENGINEERING

Case Study-7: Slope Stabilization in Vancouver, BC – Replacing a Crumbling Log Retaining Wall with Bioengineering (2018-2020)

Challenges:

A crumbling log retaining wall near a river threatened environmental damage and hefty fines if it failed.

Solution:

- Replaced the wall with a wattle fence using local materials and native plants, creating a low-cost, eco-friendly solution.

Outcome:

Within one year, the wattle fence transformed into a thriving green wall, stabilizing the slope and preventing erosion. The project not only resolved potential environmental damage but also created a habitat for local wildlife. Both the client and local government were highly impressed with the cost-effective and sustainable bioengineering solution, which demonstrated the potential of nature-based approaches in urban settings.

CASE STUDIES AND BEST PRACTICES OF BIOENGINEERING

Case Study-8: Slope Rehabilitation in Clay Soils in Vancouver, BC, Canada – Combating Seepage Erosion and Mud Flow (2020-2023)

Challenges:

Severe seepage erosion and mud flows in clay soils destabilized the slope, threatening infrastructure and communities.

Solution:

- Live pole drains (willow and cottonwood) to absorb water and reduce seepage.
- Wattle fences to slow water flow and trap sediment.
- Native willow and cottonwood species for better adaptation and growth.

Outcome:

- Site rehabilitated within one year.
- Reduced seepage erosion and mud flows.
- Stable slope with thriving vegetation.

CASE STUDIES AND BEST PRACTICES OF BIOENGINEERING

Case Study-9: Vegetated Riprap for Stream and Riverbank Protection, Vancouver, BC, Canada (2023-2024)

Challenge:
Severe erosion near bridges, green zone required balancing bank stabilization, fish habitat protection, and strict environmental compliance amid lengthy permitting.

Solution:
Manual vegetated riprap using local materials and manpower stabilized the bank, reduced erosion, and promoted natural growth in a cost-effective, sustainable, and community-driven approach.

Outcome:
Restored bank with enhanced stability, improved fish and wildlife habitats, and a proven model for sustainable riverbank protection in sensitive areas.

EMPOWERING YOUTH AND COMMUNITIES: THE HEART OF BIOENGINEERING SUCCESS

Engaging Local Stakeholders for Sustainable Bioengineering and Ecological Restoration

Aspect	Actions	Benefits
Youth Involvement	- Hands-on training in bioengineering techniques. - Lead awareness campaigns.	- Skill development. - Innovative solutions for sustainability.
Community Engagement	-Participate in planting and maintenance. -Train for long-term monitoring.	- Stronger community bonds. - Local ownership and pride.
Call to Action	- Empower youth as sustainability champions. - Foster community collaboration.	- Career opportunities. - Sustainable ecological restoration.

KEY STAKEHOLDERS AND THEIR ROLES

Process Overview – Who Should Do What:

Stage	Responsible Parties	Key Actions
Planning & Assessment	Engineers, Ecologists, Local Authorities	Conduct site assessments, design solutions, obtain regulatory approvals.
Implementation	Contractors, Technicians, Communities	Execute bioengineering techniques (e.g., plants selection, nursery sites identifications).
Monitoring & Maintenance	Environmental Agencies, Communities	Monitor bioengineering recovery, engage in long-term maintenance, and report issues.

Key Stakeholders & Their Roles:

Stakeholder	Role
Government Agencies	Provide funding, regulatory oversight, and ensure compliance with environmental standards.
Engineers & Ecologists	Design solutions, supervise implementation, and train staff and communities.
Roadside Communities	Participate in planting, nursery establishment, and long-term maintenance.
NGOs & Environmental Groups	Facilitate community engagement, education, and advocate for sustainable practices.
Contractors	Execute technical aspects and ensure quality adherence.

OVERCOMING CHALLENGES IN ROADSIDE BIOENGINEERING

CHALLENGES AND SOLUTIONS

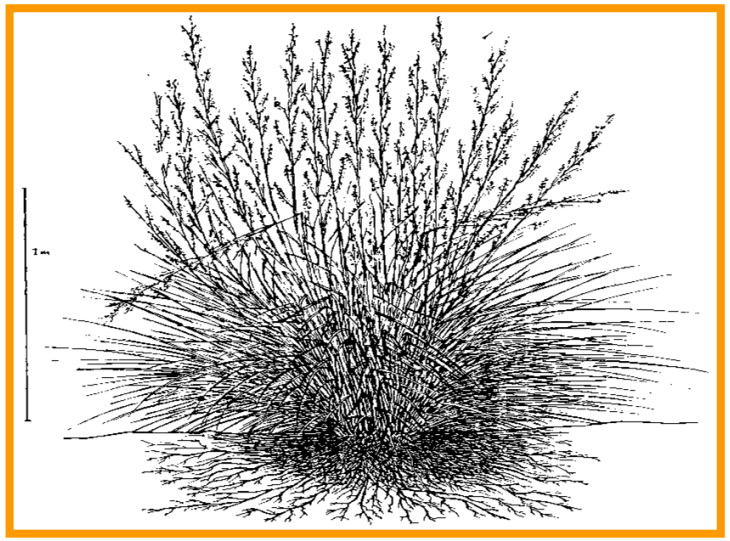
Challenges	Solutions
Lack of awareness/knowledge	Conduct training programs and workshops for stakeholders.
Limited funding	Foster public-private partnerships and seek grants.
Long-term maintenance	Empower local communities for ongoing care and monitoring.
Weather-dependent planting	Schedule planting during optimal seasons; use hardy, climate-resilient species.
Stakeholder coordination	Establish clear roles, responsibilities, and communication channels.
Site accessibility	Use lightweight equipment and manual labor for hard-to-reach areas.
Plant survival rates	Regular monitoring, maintenance, and replacement of failed plants.
Soil instability	Combine bioengineering with structural measures (e.g., geotextiles, retaining walls).
Community engagement	Conduct awareness campaigns and involve communities in decision-making.
Long-term sustainability	Develop maintenance plans and secure funding for ongoing care.

SELECTING CLIMATE-ADAPTED PLANT SPECIES FOR BIOENGINEERING

Selecting climate-adapted plants in the Bioengineering program is crucial for enhancing ecosystem resilience, ensuring sustainable landscapes, and mitigating the impacts of climate change on biodiversity and soil stability.

GRASSES:

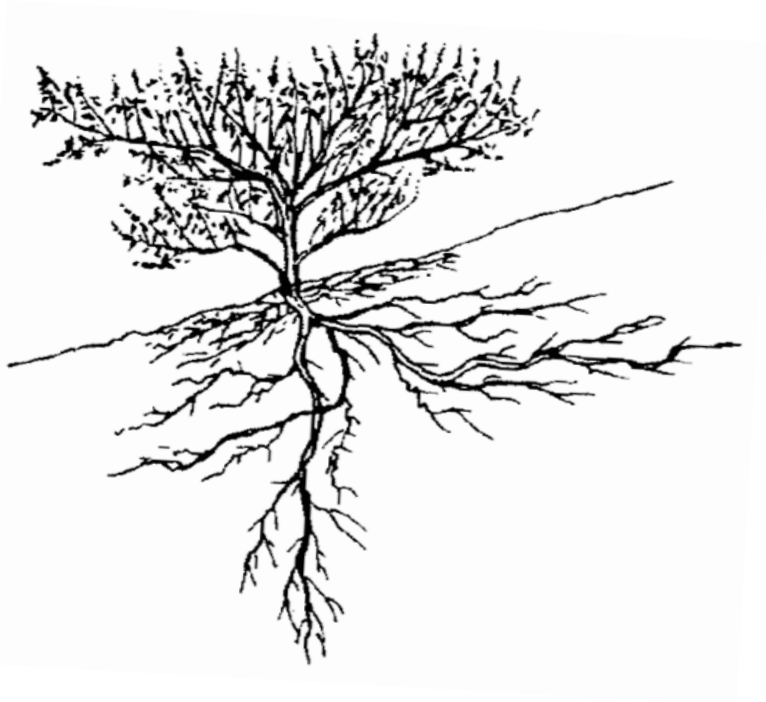
Grass species have deep and fibrous rooted system and strong clumps.



SELECTING CLIMATE-ADAPTED PLANT SPECIES FOR BIOENGINEERING

TREES:

Tree species have strong lateral roots and provide broad canopy coverage.



SELECTING CLIMATE-ADAPTED PLANT SPECIES FOR BIOENGINEERING

BAMBOOS:

Bamboo has strong lateral roots, and also provides broad canopy coverage.

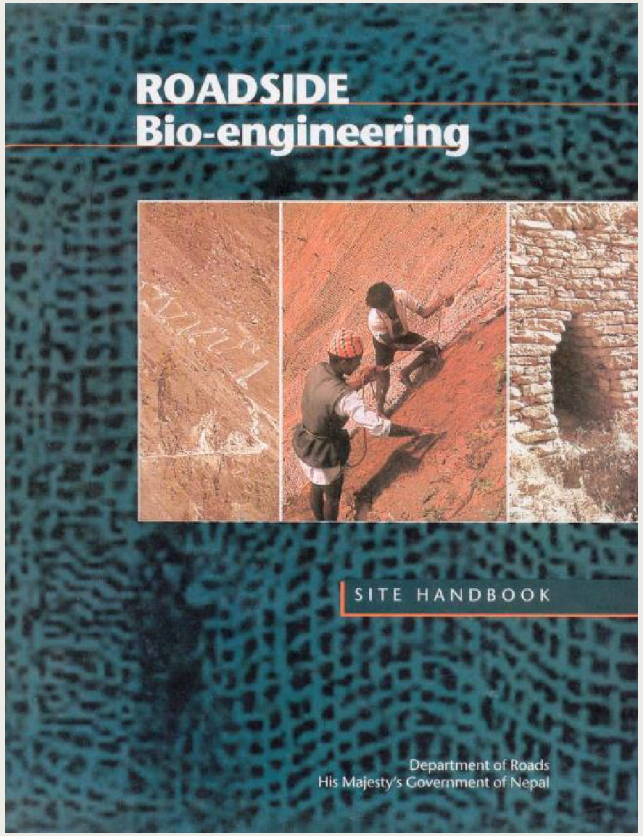
BIOENGINEERING TRAINING COURSES – THEORY AND PRACTICE
SUPERVISORS, OVERSEERS, ENGINEERS

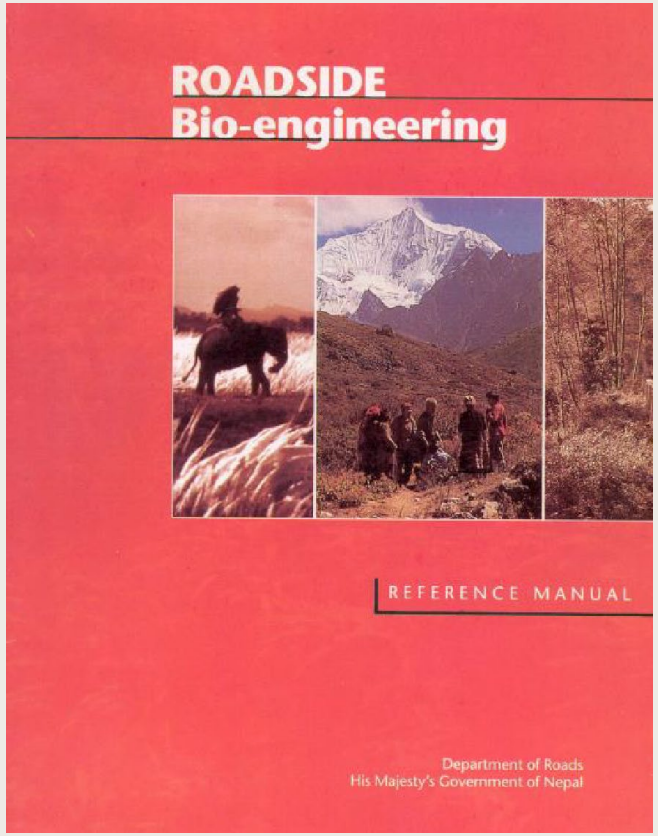
BIOENGINEERING NURSERY ESTABLISHMENT

What is a Bioengineering Nursery?

A bioengineering nursery is a dedicated facility for growing and nurturing plant species used in slope stabilization, erosion control, and ecosystem restoration. It serves as a hub for producing high-quality seedlings, cuttings, and other plant materials tailored to the specific needs of bioengineering projects.

BIO-ENGINEERING REFERENCE MATERIALS PUBLISHED AROUND THE WORLD





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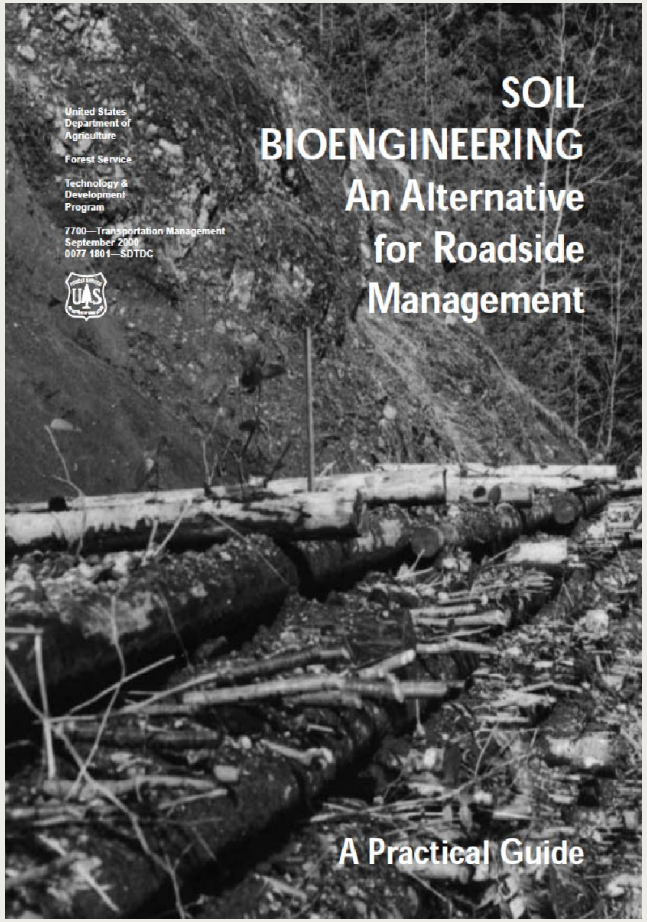
BIO-ENGINEERING REFERENCE MATERIALS PUBLISHED



Thank You. Any Questions?

"Small Actions, Big Impact: Grass slips pave the way for sustainable slope stabilization."

Let’s Stay Connected!
KALYAN THAPA
Bioengineering Consultant
ktinearth@gmail.com
Phone: +1 (604) 803-8256