



National Rural Support Programme

Biochar Learning Visit Ontario, Canada

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Report by
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Introduction

As part of NRSP Pakistan's efforts to promote sustainable agriculture, we recently completed a pilot project on biochar that delivered promising results—improving soil health, enhancing crop productivity, and supporting carbon sequestration. To build on this foundation and explore opportunities for scale-up and innovation, I undertook a learning visit to Canada, a global leader in biochar research and development.

During the visit, I engaged with stakeholders from universities, industries, and government bodies actively involved in the biochar sector. Institutions such as the University of Guelph and the University of Alberta are at the forefront of biochar science, driving progress through advanced laboratories and applied research programs. Canada also has a growing commercial biochar industry, supported by government policies focused on climate-smart agriculture, carbon offset markets, and sustainable waste management. Canadian policymakers and private sector actors are exploring biochar's potential in carbon credit frameworks, soil remediation, and forest residue utilization—particularly in response to climate change and wildfire risk. The country's integrated ecosystem of research, commercial innovation, and policy leadership makes it a valuable model for developing countries like Pakistan.

This visit provided critical insights into international best practices in biochar production, application, and commercialization. It also helped identify technologies and partnerships that could strengthen NRSP's initiatives. With our pilot project successfully completed, this learning experience represents a significant step toward scaling biochar solutions in Pakistan. Meeting list is below;

1. Meeting with Dr. Animesh Dutta – University of Guelph, Ontario
2. Meeting With Wendy Quarry, New Economy Development Group, Ottawa
3. Visit to Riverdale Biochar Farm and Forest – Inglewood, Ontario, Canada. (Meeting with Mr. Owen Goltz – Community-Based Biochar and Wood Vinegar Production)
4. Meeting with Dr. Jodi Formosi – CEO, Bella Biochar Corporation/ Western University Collaborative Industry Partner (Oakville, Canada)
5. Meeting with Dr. Muhammad Arslan – University of Alberta, Canada
6. Meeting with Dr. Atique Rehman – Senior Scientific Project Coordinator, Ministry of Health, Government of Canada, Ottawa.

Meeting with Professor Dr. Animesh Dutta – University of Guelph, Ontario

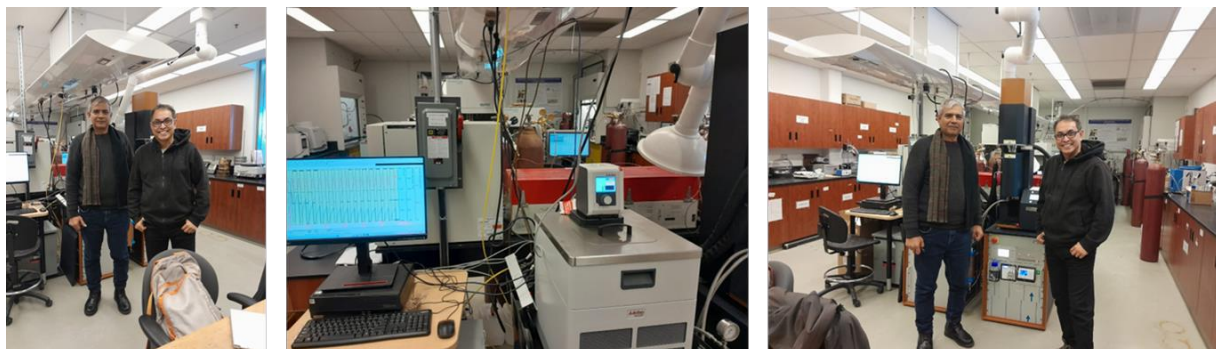
As part of my learning visit to Canada, On Wednesday February 5, 2025, I had the privilege of meeting Dr. Animesh Dutta, Professor at the School of Engineering and Founding Director of the Bio-Renewable Innovation Lab (BRIL) at the University of Guelph. Dr. Dutta is widely recognized for his pioneering research in biomass conversion technologies and sustainable bioenergy solutions. His work focuses on transforming organic and agricultural waste into high-value products such as biochar, bio-oil, and syngas—advancing the circular economy and supporting sustainable development goals.

Our meeting centered around the technical and strategic aspects of scaling up biochar production. Dr. Dutta shared in-depth insights into thermochemical processes such as hydrothermal carbonization (HTC), which is particularly effective in converting wet biomass into energy-dense biocarbon. He emphasized the importance of selecting the right equipment and process design for efficient, scalable, and environmentally responsible biochar production. His practical knowledge, drawn from leading research and operating pilot-scale systems, was especially relevant to the ongoing work at NRSP.



A key part of our interaction involved presenting the results of NRSP's recent biochar pilot project in Pakistan. I gave a detailed presentation covering our production methods, field application results, and the strong community engagement model we employed. Dr. Dutta and his PhD students showed significant interest in our approach. They asked a range of thoughtful and technical questions regarding the process, quality of biochar, soil health impact, and stakeholder involvement. I responded in detail, and the team expressed appreciation for the quality of our results—particularly our focus on community participation, consistent production standards, and the measurable improvement in soil health outcomes.

We also discussed potential collaborative opportunities between NRSP and BRIL. Dr. Dutta expressed keen interest in partnering on R&D initiatives that adapt biochar technologies to Pakistan's specific agricultural and environmental contexts. These collaborations could facilitate knowledge exchange, technical support, and innovation tailored to local needs. Another area of discussion was market development. Dr. Dutta shared valuable perspectives on integrating biochar into commercial markets—highlighting its use as a soil amendment, a carbon sequestration tool, and a component of renewable energy systems. He emphasized that quantifying and demonstrating both economic and environmental benefits is essential for broader adoption. To conclude the meeting, I toured the BRIL research facility. The lab is equipped with advanced tools for biomass characterization and conversion, offering a comprehensive platform for experimentation and innovation. I interacted with Dr. Dutta's PhD students and observed their research projects, many of which align closely with the goals of NRSP's work. This



visit provided valuable insights that will directly support the scaling and refinement of our biochar initiatives in Pakistan.

Key Takeaways:

There are three key takeaway points and corresponding recommendations as a conclusion to my meeting with Dr. Animesh Dutta at University of Guelph

Technical Alignment for Scalable Biochar Production

Dr. Dutta emphasized that successful scale-up of biochar operations hinges on selecting the right thermochemical process—such as hydrothermal carbonization (HTC) and Pyrolysis¹, process that matches the feedstock type and environmental conditions. His insights reinforced the importance of context-specific technology adoption for regions like Pakistan. Biochar and Hydrochar are both carbon-rich materials produced from biomass, but they are created through different processes and have distinct physical, chemical, and environmental properties. Their utilization overlaps in some areas but differs in others due to how they are made and what they contain. The main difference between both are listed below;

Feature	Pyrolysis Process	Hydrothermal Carbonization (HTC)
Feedstock moisture	Needs dry biomass	Works with wet biomass
Reaction medium	No oxygen (dry heat)	Hot, pressurized water
Main product	Biochar	Hydrochar
Equipment complexity	Generally simpler	More complex and high-pressure
Energy use	Higher (due to drying needs)	Lower for wet feedstocks

Value of Applied Research and Community-Driven Models

The positive response from Dr. Dutta and his PhD students to NRSP's pilot—especially its focus on community engagement and measurable field results—validated the relevance of participatory approaches in applied biochar research and implementation.

Collaborative Potential for R&D and Market Integration

There is strong mutual interest in formalizing collaboration between NRSP and the Bio-Renewable Innovation Lab. Dr. Dutta highlighted potential areas of joint research, knowledge exchange, and market development strategies that could strengthen Pakistan's biochar ecosystem.



¹ NRSP using Pyrolysis process for its biochar pilot

Meeting With Wendy Quarry, New Economy Development Group, Ottawa

During my field visit to Ottawa on Monday, February 10, 2025, I met with Ms. Wendy Quarry, a Canadian expert in development and social change with deep connections in the biochar and sustainable agriculture sectors. Ms. Quarry provided a comprehensive overview of the current state of the biochar industry in Canada. She noted that the country has a rich and diverse supply of biomass—particularly forestry residue, agricultural waste (such as straw, corn stalks, and manure), and organic municipal waste—that can be effectively converted into biochar. Among these, woody biomass from sustainably managed forestry operations is considered one of the most stable and climate-friendly sources due to its carbon retention capacity and consistent quality.

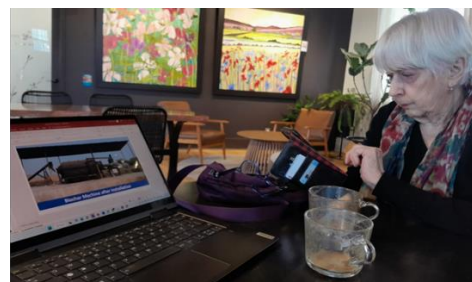
Our discussion covered the entire biochar value chain, including production techniques, emerging standards, and regulatory gaps. Ms. Quarry emphasized that while biochar production is growing, clear national guidelines on quality standards and safety protocols are still evolving. She also highlighted the importance of aligning biochar research with practical applications, such as soil amendment, carbon sequestration, and water retention in agriculture. Organizations like Qualterra, Haliburton Forest Biochar, and Farms at Work are actively involved in both R&D and farmer outreach to improve biochar awareness and adoption.

On industry engagement and marketing, Ms. Quarry pointed out that the Canadian biochar sector is still in its early commercialization stage, but there's increasing interest from environmental groups, government bodies, and agri-tech companies. She stressed the need for stronger market development strategies, certification systems, and incentive-based policies to scale up biochar utilization. Her insights underscored that biochar, if integrated wisely into Canada's climate and agricultural strategy, holds substantial potential to contribute to both environmental and economic sustainability.

The two clear takeaway points from the discussion with Ms. Wendy Quarry, specifically regarding biochar work in Pakistan are:

1. Leverage Agricultural Residue with Localized Solutions

Ms. Wendy emphasized that Pakistan has a high potential for biochar production due to its abundant agricultural residues such as wheat straw, rice husks, cotton stalks, and sugarcane bagasse. She



suggested that rather than importing technologies, Pakistan should focus on developing low-cost, locally adaptable biochar production methods tailored to regional biomass types and farming practices. This would enhance both climate resilience and soil productivity at the grassroots level.

2. Build Awareness, Policy Support, and Farmer Engagement

She highlighted the importance of building awareness among policymakers and farmers in Pakistan about the benefits of biochar—not just as a soil amendment, but as a tool for carbon sequestration and climate mitigation. Ms. Wendy encouraged Pakistan to invest in pilot projects, develop national standards, and create partnerships between research institutions, the private sector, and rural farmer networks to accelerate adoption and ensure long-term impact.

Ms. Wendy Quarry also recommended that I connect with the local farmers' network radio group in Ontario, which has been actively involved in biochar awareness and field-level innovation. Through her facilitation, I was introduced to the network and had the opportunity to discuss NRSP's pilot biochar initiative with them. The exchange proved insightful, offering practical perspectives on farmer-led trials, outreach strategies, and community-level adoption in Canada. As part of this engagement, I also visited Mr. Owen Goltz's biochar facility located in Inglewood which is 63 kilometer from Toronto, where I observed small-scale biochar production processes using forestry and agricultural waste. The visit provided valuable learning on technical setup, feedstock handling, and the integration of biochar into commercial farming systems.



Visit to Riverdale Biochar Farm and Forest – Inglewood, Ontario, Canada. (Meeting with Mr. Owen Goltz – Community-Based Biochar and Wood Vinegar Production)

As part of the learning visit to Canada, I visited Riverdale Farm and Forest, located at 15707 McLaughlin Rd, Inglewood, Ontario. The farm is owned and operated by Mr. Owen Goltz and his wife Susan Graham, who have been practicing regenerative agriculture on the property for over 25 years. The farm serves as a local hub for sustainable practices and innovation in soil health.

Mr. Goltz is producing biochar and wood vinegar on-site and has developed a community-based biochar production model. We toured his biochar facility, wood vinegar unit, farm nursery, and surrounding production fields, observing firsthand the application of sustainable farming practices.

He demonstrated how biochar and wood vinegar are produced and shared their multiple benefits, including:

- Improving soil health and structure
- Enhancing water retention
- Reducing greenhouse gas emissions from soil
- Lowering soil acidity
- Reducing irrigation and fertilizer requirements
- Increasing resistance to soilborne pathogens and foliar fungal diseases



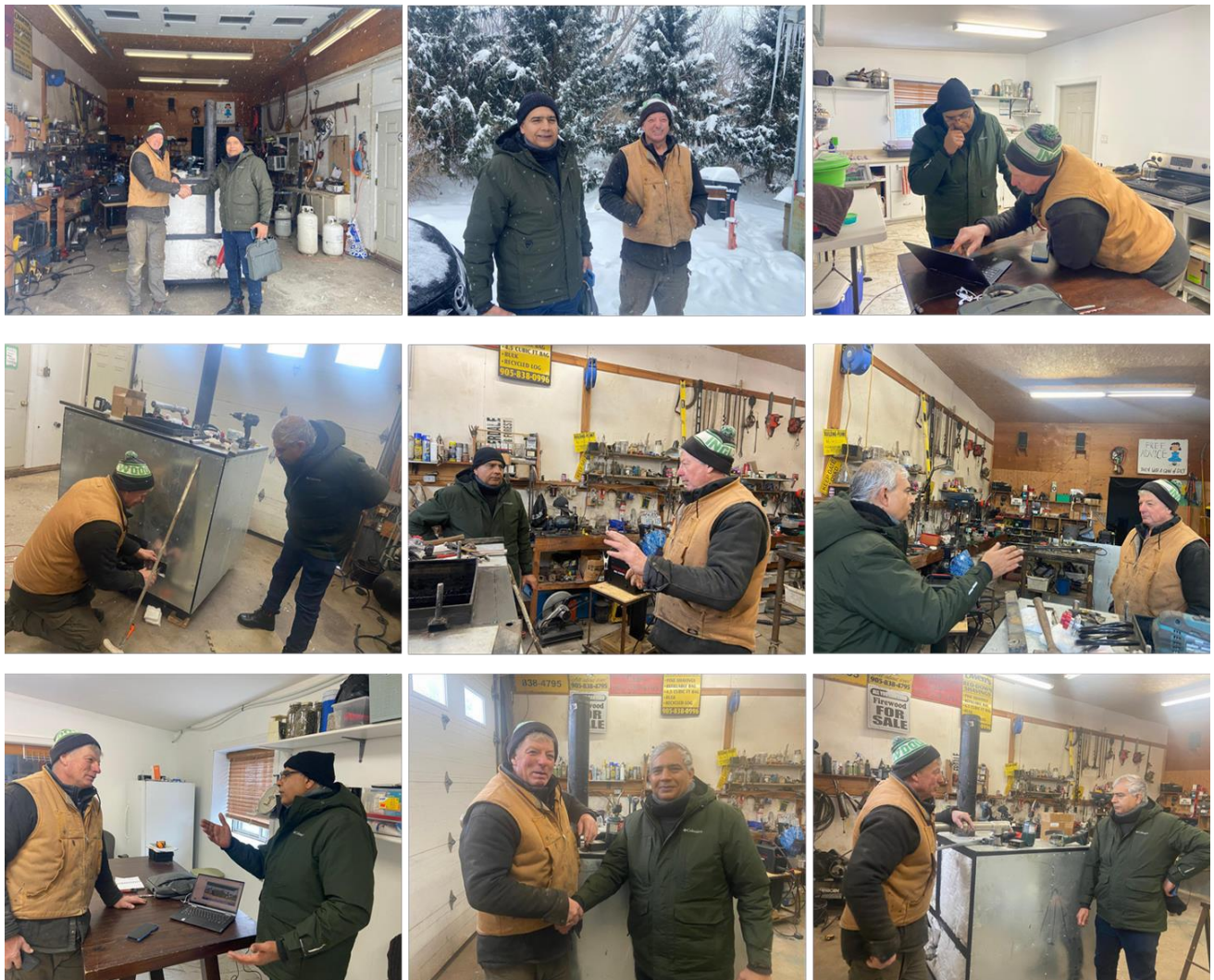
He also integrates biochar use into various aspects of the farm, including:

- Vegetable and fruit cultivation
- Seed inoculation programs
- Composting systems and compost tea brewing
- Forage and cover crop enhancement
- Animal husbandry practices

In addition to biochar, Mr. Goltz produces wood vinegar, a byproduct with applications in plant health and soil conditioning. His production unit is portable, energy-efficient, and built using innovative, low-cost techniques, making it suitable for replication in small-scale farming contexts.

Mr. Goltz and Susan are deeply committed to community development. They actively engage local farmers and promote nutrient-dense food production through:

- Crop rotation
- Use of non-GMO seeds
- Full reuse of plant material as compost



- Natural, sustainable soil enrichment methods

Mr. Goltz expressed strong interest in supporting similar initiatives in Pakistan. He is willing to provide technical support for a pilot project and is open to visiting Pakistan to offer hands-on guidance, should an invitation be extended. This visit provided valuable insights into scalable, community-driven approaches to biochar and sustainable farming that can inform NRSP's future initiatives.

Key Takeoff Points from Visit to Riverdale Biochar Farm and Forest, Ontario, Canada

- **Scalable Community-Based Biochar Model:**

Mr. Owen Goltz's low-cost, energy-efficient biochar and wood vinegar production system demonstrates a replicable model for small-scale farmers, particularly suitable for rural and resource-constrained contexts like Pakistan. His integration of biochar into composting, seed inoculation, and animal husbandry offers a holistic, sustainable approach to regenerative agriculture.

- **Proven Soil and Plant Health Benefits:**

The use of biochar and wood vinegar significantly improves soil structure, moisture retention, disease resistance, and reduces the need for fertilizers and irrigation. These benefits directly support climate-resilient farming and could enhance agricultural productivity in arid regions such as Balochistan.

- **Opportunity for Collaboration and Pilot Projects:**

Mr. Goltz has expressed a willingness to support pilot implementation in Pakistan, including technical advisory and potential in-country visits. This opens the door for NRSP to explore a strategic partnership for piloting community-based biochar production, aligning with NRSP's goals of environmental sustainability and rural livelihoods improvement.



Meeting with Dr. Jodi Formosi – CEO, Bella Biochar Corporation/ Western University Collaborative Industry Partner (Oakville, Canada)

February 09, 2025, visited Bella Biochar Corporation, this is located at Oakville, 37 km from Toronto and met with Dr. Jodi Formosi, CEO and Founder of Bella Biochar Corporation, was aimed at exploring industry-led innovations in biochar technology, understanding commercial-scale operations, and identifying areas for technical and strategic collaboration with NRSP Pakistan. Dr. Formosi, a globally recognized figure in the biochar industry and the first female CEO certified by PURO Earth, is at the forefront of regenerative environmental solutions and carbon removal through biochar. Bella Biochar's leadership in Canada and its international certification credentials made this an important engagement for NRSP's future scale-up plans. As an industry partner with Natural Sciences and Engineering Research Council of Canada (NSERC) and Western University, Dr. Jodi bridges scientific research and practical application in biochar technology, contributing to Canada's Net Zero goals.

Key Discussion Points

Dr. Jodi shared that Biochar is a carbon-rich, charcoal-like substance produced by heating organic biomass, such as wood waste, crop residues, manure, or other agricultural byproducts, under limited oxygen conditions, a process known as pyrolysis or carbonization. The term "biochar" combines the Greek word bios (meaning "life") with "char" (referring to the carbonized material). Because it is made from biomass that has stored solar energy in chemical form, biochar serves as a powerful tool in carbon management. Its high carbon content, porous structure, and alkaline properties make it valuable in a wide range of agricultural, environmental, and industrial applications. Biochar improves soil fertility, enhances water retention, supports microbial activity, and contributes to long-term carbon sequestration, making it a critical input in sustainable land use and climate resilience strategies. Her focus areas are agriculture, environment and industry. She shared her findings about biochar application in the agriculture Canada, such as

- Used as a soilless growing media
- Reduces crop loss and risk
- Increases plant yield
- Shortens crop cycles
- Fully reusable and Safe to Handle
- Pure, inert, and contaminate free



I shared detailed insights into NRSP's pilot project, including our production model, community engagement strategy, and field results. Dr. Formosi and her team showed strong interest and asked technical and operational questions, particularly around feedstock use, soil health outcomes, and local scalability. Dr. Formosi provided an in-depth overview of her company's manufacturing model. Bella Biochar uses a non-pyrolytic, mobile biochar processor fueled by clean energy and optimized for high-carbon stability. The system is designed for continuous feed, with a production capacity of 10 tons/hour, and runs on landfill-diverted wood waste. She shared valuable knowledge on biochar packaging, branding, and marketing strategies tailored to different application sectors (agriculture, aquaculture, water remediation, cosmetics, etc.).

Dr. Formosi elaborated on Bella Biochar's PURO Earth certification process and participation in international voluntary carbon markets. She explained how every metric ton of Bella Biochar sequesters approximately three metric tons of CO₂ for 1,000 years. She also shared variety of biochar samples produced at Bella Biochar, demonstrating its structure, purity, and potential applications. A formal proposal was handed over (attached), outlining support for equipment, training, market intelligence, certification guidance, and potential technology transfer to NRSP.

Lessons and Takeaways

Canada's commercial biochar sector is highly organized and closely tied to global carbon and biodiversity markets.

- Verifiable carbon removal and biodiversity credits present real revenue streams, provided production meets international standards.
- Mobile and clean-energy biochar units can offer flexibility and scalability for rural settings like those in Pakistan.
- Branding, packaging, and multi-sector applications are critical to expanding biochar's economic viability.
- Partnerships with certified operators can fast-track NRSP's access to global certification and trade networks.

Opportunities for Collaboration

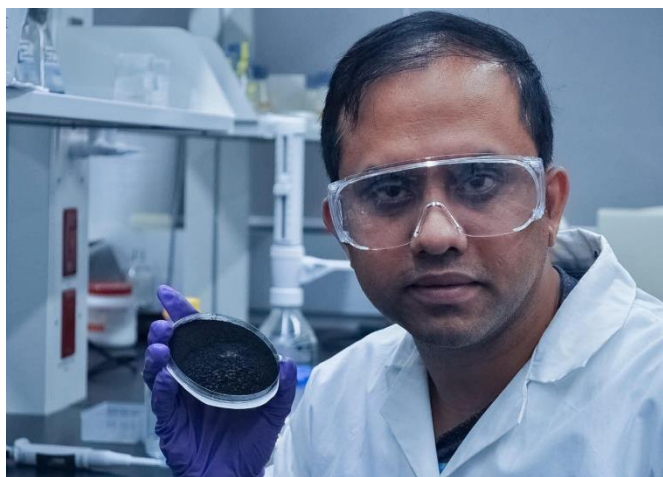
Dr. Formosi expressed strong interest in collaborating with NRSP, potentially through a technology transfer or joint venture model. Technical Training & Certification: Bella Biochar is willing to provide hands-on training, detailed SOPs, and support in acquiring international certifications (carbon credits, biodiversity credits, etc.). Pilot Project in Pakistan: The proposal outlines a plan to bring Bella's mobile



processor technology to Pakistan with an estimated project cost of USD 1.5 million, inclusive of installation, training, and knowledge transfer.

Meeting with Dr. Muhammad Arslan – University of Alberta, Canada

February 14, 2025, I got opportunity to talk with Dr. Muhammad Arslan, an environmental engineering researcher at the University of Alberta known for his work on biochar-based environmental technologies. Our meeting focused on knowledge exchange, particularly around the environmental and agricultural applications of biochar. I shared insights from NRSP Pakistan's recent biochar pilot project, which demonstrated measurable improvements in soil health, crop yield, and community engagement through low-cost, scalable biochar production models. I presented the process design, pyrolysis parameters, and field results, emphasizing the role of participatory rural development in achieving our success. Dr. Arslan showed keen interest in our findings, asking targeted questions about feedstock types, temperature regimes, surface area enhancement techniques, and the observed agronomic impacts. He appreciated the strong applied nature of NRSP's work, particularly the integration of field trials with farmer feedback loops and decentralized production models suited to Pakistan's rural context.



In return, Dr. Arslan shared details of his research into the environmental remediation potential of biochar, particularly its use in wastewater treatment and pollutant adsorption. He discussed innovations in modifying biochar surface chemistry to improve sorption efficiency for contaminants such as heavy metals and nutrients—highlighting its potential as a sustainable and low-cost solution for environmental cleanup. His ongoing projects include the development of biochar-enhanced filtration media and carbon-rich sorbents tailored for municipal and industrial wastewater systems. The discussion revealed strong alignment between NRSP's agricultural applications of biochar and Dr. Arslan's environmental engineering approach. We explored opportunities for collaboration in future projects involving modified biochar for integrated soil and water remediation. Dr. Arslan also emphasized the importance of



characterizing biochar physicochemical properties using advanced analytical tools to better correlate biochar structure with environmental function. This exchange provided rich insights into biochar's interdisciplinary potential and laid the groundwork for future academic and technical partnerships between NRSP and Canadian institutions.

Key Takeaways from Meeting with Dr. Muhammad Arslan – University of Alberta

- Integration of Biochar for Environmental and Agricultural Remediation
The discussion highlighted the dual functionality of biochar as both a soil amendment and an environmental remediation tool. Dr. Arslan emphasized its ability to adsorb heavy metals and nutrients when engineered properly—offering opportunities to combine soil improvement with water treatment in Pakistan's agro-industrial zones.
- Value of Modified Biochar in Wastewater Treatment
Dr. Arslan shared valuable insights into modifying biochar through surface treatments to enhance pollutant capture. This presents an innovative direction for NRSP to explore low-cost, sustainable solutions for industrial and agricultural wastewater management, particularly in areas facing groundwater contamination.
- Potential for Collaborative Research and Technical Capacity Building
There was strong alignment in goals between NRSP's field-based work and Dr. Arslan's lab-driven innovations. Both parties expressed interest in future collaboration—particularly in characterizing biochar properties and co-developing multifunctional biochar applications. This opens avenues for knowledge exchange, research internships, and pilot projects in Pakistan.



Meeting with Dr. Atique Rehman – Senior Scientific Project Coordinator, Ministry of Health, Government of Canada, Ottawa.

With the help of Mr. Azam Khan Tareen (ex NRSP Employee), able to fix meeting with Dr. Atique Rehman, Senior Scientific Project Coordinator at the Ministry of Health, Government of Canada. Dr. Rehman brings extensive experience in scientific policy development, public health standards, and regulatory protocols. Our discussion focused on the importance of developing standardized practices and regulatory frameworks for the production and application of biochar, especially in the context of emerging economies like Pakistan.



Dr. Rehman emphasized that as biochar adoption grows globally, it is essential for countries to establish clearly defined Standard Operating Procedures (SOPs) and quality benchmarks to ensure safety, consistency, and credibility particularly when biochar is used in agriculture, environmental remediation, or as part of carbon offset mechanisms. He highlighted Canada's approach to scientific regulation, including cross-department collaboration and evidence-based policy design, as a reference point for how Pakistan might structure its own biochar guidelines. He also stressed that Pakistan's efforts in piloting biochar are timely, but must be supported by rigorous research, stakeholder coordination, and standardization across sectors. Developing SOPs for biochar production, storage, application, and environmental safety would not only improve adoption at scale but also open doors to international recognition and participation in carbon and biodiversity credit markets.

Dr. Rehman encouraged NRSP to initiate dialogues with Pakistan's environmental, agricultural, and standardization bodies to begin formulating a national framework. He also offered to provide informal guidance and facilitate knowledge-sharing opportunities with Canadian experts in related fields. This meeting underlined the critical role of governance, quality control, and scientific standards in positioning biochar as a credible and scalable solution for sustainable development in Pakistan.

Key Take-Off Points

- **Urgent Need for SOPs in Pakistan:** Pakistan should develop Standard Operating Procedures (SOPs) for biochar production, handling, and application to ensure consistency, safety, and credibility.
- **Focus on Quality Standards:** Establishing national biochar quality standards is essential for building trust, supporting large-scale adoption, and aligning with global carbon and environmental markets.
- **Policy and Regulatory Framework:** Pakistan should initiate work on a formal regulatory framework for biochar, involving relevant government departments (agriculture, environment, and industry).

- International Market Access: Adhering to standards is critical for participation in international carbon credit and biodiversity credit markets.
- Offer of Guidance: Dr. Rehman expressed willingness to support NRSP with technical advice and connect Pakistani stakeholders with Canadian experts.



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