

Collaborative Research Agreement

Summary and Signature Page

This agreement ("Agreement") is effective as of the last signature date below ("Effective Date") and is between **King Abdullah University of Science and Technology** ("KAUST") and **UNIVERSIDADE ESTADUAL DO OESTE DO PARANA** ("UNIOESTE"), hereinafter referred to respectively as "Party" or as "Parties" to this Agreement.

UNIVERSIDADE ESTADUAL DO OESTE DO PARANA	KAUST
Universidade Estadual do Oeste de Parana R. Universitária, 1619 Universitário, Cascavel PR, 85819-110 Brazil	King Abdullah University of Science and Technology Office of Research Administration Thuwal, Jeddah 23955-6900 Kingdom of Saudi Arabia
Agreement Reference: KAUST: #5137 UNIOESTE:	Agreement Action: <input checked="" type="checkbox"/> New <input type="checkbox"/> Amendment No.:
Project Title (the "Project"): <i>Preparation and characterization of biochar derived from various feedstocks, pyrolytic conditions, and chemical activation for aridland greening/agriculture efforts</i>	Principal Investigator/Technical Officer: KAUST: Professor Himanshu Mishra UNIOESTE: Professor Edson da Silva
Period of performance ("Project Term"): Project Start Date: 1 August 2022 Duration (months): 36 Project End Date: 31 July 2025	Funding: Currency: <input checked="" type="checkbox"/> USD / <input type="checkbox"/> SAR Total awarded ('Project Funds'): \$50,000 Total cost sharing required: \$0
Incorporated Appendices. <input checked="" type="checkbox"/> Authorized Contacts List <input type="checkbox"/> Industry Sponsor Terms and Conditions <input type="checkbox"/> Subaward Terms and Conditions <input checked="" type="checkbox"/> Collaboration Terms and Conditions	<i>Items checked below are incorporated into this Agreement:</i> <input checked="" type="checkbox"/> Statement of Work (or Approved Proposal) <input type="checkbox"/> Budget <input type="checkbox"/> Reporting Template(s) <input type="checkbox"/> Other:
<p>This Agreement, consisting of this signature page and the incorporated appendices marked above, embodies the entire understanding of the Parties for this Project, superseding any prior or contemporaneous representations, either oral or written regarding this matter. This Agreement can only be modified by written agreement duly signed by persons authorized to sign agreements on behalf of each Party. Each signatory below certifies that they are authorized to execute legally binding commitments on behalf of their named Party. The Parties to this Agreement agree that a copy of original signature(s), including scanned/electronic copy, can substitute original signature(s). The Parties further waive the right to challenge the admissibility or authenticity of this document in a court of law based solely on the absence of original signature(s).</p>	
For: UNIVERSIDADE ESTADUAL DO OESTE DO PARANA Signature: _____ Name, Title: Alexandre Almeida Webber Rector Date:	For: KING ABDULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY Signature: <i>Pierre Magistretti</i> Name, Title: Pierre Magistretti Vice-President for Research Date: 28-Aug-2022 12:06 ABST

Schedule A. Authorized Contacts List

UNIVERSIDADE ESTADUAL DO OESTE DO PARANA	KAUST
<p>Principal Investigator/Technical Contact:</p> <p>Name: Edson Antonio da Silva Title: Professor Email: edsondeg@hotmail.com Phone: +55 45 3379-7039 Address: Universitária Street, 1619, CEP 85819-110, Cascavel, Paraná, Brazil</p>	<p>Principal Investigator/ Technical Contact:</p> <p>Name: Himanshu Mishra Title: Associate Professor of Environmental Science Email: Himanshu.Mishra@kaust.edu.sa Phone: +966-(0)12-808-2110 Address: KAUST, Al-Jazri Building (4), Thuwal, Jeddah 23955-6900, Kingdom of Saudi Arabia</p>
<p>Financial Contact:</p> <p>Name: Mari Presrlak Title: Email: fundep@fundeppr.com.br Phone: Address: Universitária Street, 1619, CEP 85819-110, Cascavel, Paraná, Brazil</p>	<p>Financial Contact:</p> <p>Name: Victor Otoadese Title: Business Manager Email: Victor.Otoadese@kaust.edu.sa Phone: +966-(0)12-808-0835 Address: KAUST, Al-Jazri Building (4), Thuwal, Jeddah 23955-6900, Saudi Arabia</p>
<p>Contractual Contact:</p> <p>Name: Rafael Matiello Title: International Officer Email: internacional@unioeste.br Phone: +55 45 3220-5682 Address: Universitária Street, 1619, CEP 85819-110, Cascavel, Paraná, Brazil</p>	<p>Contractual Contact:</p> <p>Name: Linda Polik Title: Senior Awards and Contracts Specialist Email: ORA.Contracts@kaust.edu.sa Phone: +966-(0)12-808-2183 Address: KAUST, Administration Building (16), Thuwal, Jeddah 23955-6900, Kingdom of Saudi Arabia</p>
<p>Technology Transfer/Invention Disclosure:</p> <p>Name: Reginaldo Ferreira dos Santos Title: Coordenador do Núcleo de Inovações Tecnológicas - NIT Email: nit@unioeste.br Phone: +55 45 3220-5708 Address: Universitária Street, 1619, CEP 85819-110, Cascavel, Paraná, Brazil</p>	<p>Technology Transfer/Invention Disclosure:</p> <p>Name: Sean Flanigan Title: Director, Technology Transfer Office Email: ip@kaust.edu.sa Phone: +966-(0)12-808-8316 Address: KAUST, Administration Building (16), Thuwal, Jeddah 23955-6900, Kingdom of Saudi Arabia</p>
<p>Authorized Representative:</p> <p>Name: Geysler Rogis Flor Bertolini Title: Pró-Reitor de Administração e Finanças Email: geysler.bertolini@unioeste.br Phone: +55 45 3220-3097 Address: Universitária Street, 1619, CEP 85819-110, Cascavel, Paraná, Brazil</p>	<p>Authorized Representative:</p> <p>Name: Erwan Arzel Title: Director, Research Operations Email: ORA.Contracts@kaust.edu.sa Phone: +966-(0)12-808-4149 Address: KAUST, Administration Building (16), Thuwal, Jeddah 23955-6900, Kingdom of Saudi Arabia</p>

- End of Schedule A. Authorized Contacts List -

Schedule B. Terms and Conditions

1. DEFINITIONS

“Background Intellectual Property” - Intellectual property that is developed prior to the Project Start Date or thereafter independently in parallel or after the Agreement without the other Party’s confidential Information.

“Confidential Information” - Information embodied in oral, written, digital, biological, chemical, or other tangible form, that is deemed confidential and/or proprietary by the disclosing party and is marked with a “Confidential” or “Proprietary” restrictive legend, or if in intangible form (i.e. oral or visual), be identified as confidential or proprietary at the time of disclosure and in writing within ten (10) days thereafter as confidential or proprietary.

“Data” - means any data of any nature, in any form, collected, generated, processed or used for or in relation to the Project, including Personal Data.

“Force Majeure” - means in relation to either Party any event or circumstance which is beyond the reasonable control of that Party and which results in or causes the failure of that Party to perform any or all of its obligations under this Agreement including act of God, lightning, fire, storm, flood, earthquake, accumulation of snow or ice, lack of water arising from weather or environmental problems, global pandemic, strike, lockout or other industrial or student disturbance, act of the public enemy, war declared or undeclared, threat of war, terrorist act, blockade, revolution, riot, insurrection, civil commotion, public demonstration, sabotage, act of vandalism, prevention from or hindrance in obtaining in any way materials, energy or other supplies, explosion, fault or failure of plant or machinery (which could not have been prevented by good industry practice), governmental restraint, act of legislature and directive or legal requirement governing any Party: provided always that lack of funds shall not be interpreted as a cause beyond the reasonable control of that Party.

“Intellectual Property (IP)” - All (i) inventions (whether patentable or unpatentable and whether or not reduced to practice), and all improvements thereto, (ii) patents, patent applications, and patent disclosures; (iii) trademarks, service marks, trade names, domain names and logos, and all goodwill associated therewith; (iv) works of authorship, copyrights, whether registered or unregistered (including copyrights in software), “moral” rights and applications for copyright registrations; (v) confidential and proprietary information, or non-public processes, procedures, trade secrets, designs, drawings, specifications, technology, know-how, techniques, algorithms, databases and data collections, formulas, concepts, developments, improvements, marketing plans, ideas and technical data and information, all software; (vi) all moral and economic rights of authors and inventors, however denominated; (vii) divisions, continuations, renewals, reissuances, and extensions of the foregoing (where applicable); (viii) to the extent not covered by the foregoing; and (ix) any similar or equivalent rights to any of the foregoing, throughout the world.

“Project Intellectual Property (IP)” - Intellectual Property created, conceived, or reduced to practice in the performance of the Project.

2. MONITORING

The KAUST Principal Investigator is responsible for managing and monitoring the Project, function or research activities supported by KAUST. Collaborator is responsible for managing and monitoring the Project, function or research activities supported by Collaborator funds, which are carried out by Collaborator personnel on Collaborator premises, or subcontracted to third parties. Final decisions on the scientific issues and direction of the Project shall be made jointly by the Principal Investigators.

3. PROJECT MANAGEMENT AND REPORTING

Close liaison between the Parties will be necessary throughout the Project in order to ensure on-time completion of all tasks. The Parties shall communicate by telephone or participate in technical conferences to exchange technical data, coordinate fabrication tasks or schedules and, in general, perform necessary liaison to maintain an "on schedule" effort. The Parties shall participate in a quarterly conference call or teleconference on a mutually agreed upon schedule. The Parties shall submit quarterly progress reports in writing to each other at quarterly intervals and in agreed upon formats.

4. Costs and Payments

4.1 KAUST shall provide funding for the research to be carried out under the Project at Collaborator in accordance with this Agreement. The sole financial obligation of KAUST under this Agreement shall not exceed the amount of Project Funds indicated in this Agreement, subject to the terms and conditions set forth herein.

Payments shall be made in accordance with the Schedule below and upon receipt of

- a) a technical progress report in agreed upon intervals,
- b) an invoice from Collaborator, and
- c) the agreed Deliverables from Collaborator, if approved and accepted by the KAUST Principal Investigator.

For the final payment, in addition to the requirements listed under (a), (b) and (c) and subject to Section 4.2 below, a final financial report is due within 45 days of the end of the Project, showing the actual costs incurred for the whole Project Term.

4.2 The Final Financial Report is based on actual cost reimbursement. For the final payment, KAUST shall reimburse Collaborator all actual, allowable costs against the total Project Funds awarded minus any payments made previously, applicable adjustments and penalties, in the final payment. Where the amount of the corresponding total amount spent is less than the amount already paid to Collaborator, KAUST shall recover the difference.

4.3 All payments shall be made in US Dollars (\$USD). Collaborator shall invoice KAUST electronically for each payment by emailing KAUST Financial Contact in Schedule A of this Agreement, which invoices shall be paid within sixty (60) days of receipt by international bank transfer. Except for the above contribution from KAUST to Collaborator, each Party shall bear its own costs and expenses, including travel costs and employment compensation, in connection with the Project; but in no event will one Party subsidize any extraordinary research costs of the other. The Parties do not anticipate purchasing specialized equipment and/or consuming rare or specialized laboratory consumables in the other Party's facilities. If pursuant to this Agreement the Parties propose to so expand this Project or develop any new research project, the Parties shall either amend this Agreement or enter into a new agreement.

5. EXCHANGES AND VISITS

The Parties contemplate that each may assign personnel and/or students to the other Party's facility to participate in or observe the work being done under the Project. The host Party ("Host") shall have the right to exercise routine administrative and technical oversight of the professional activities of visiting Personnel during the visit in accordance with its institutional policies; and shall have the right to approve or decline the specific personnel or students before such assignment; and shall have the right to request their removal on reasonable notice. The visiting Personnel shall fully comply with the host Party's working hours, security and safety rules and laboratory regulations and procedures, and any other applicable policies and procedures of the Host (collectively, "Host Policies, Procedures & Agreements") subject to 5(a) and (b) below. If applicable, all visitors shall be expected to comply fully with any appropriate export control regulations and the conditions set forth therein.

- a) With regard to the development of any Project IP arising during the performance of the Project, if any Host Policies, Procedures & Agreements conflict with this Agreement, then the terms of Section 9 [Project Intellectual Property] of this Agreement take precedence over such Host Policies, Procedures & Agreements.
- b) With regard to the development of Intellectual Property that is not Project IP arising during the performance of the Project or Research Results, and is developed outside the scope of this Project, all terms of a host organization's Host Policies, Procedures & Agreements will apply and will take precedence over this Agreement.

6. TRANSFER OF MATERIALS

- 6.1 Each Party ("sending Party") may provide to the other ("receiving Party") certain scientific and experimental research Material as part of their collaboration under the Project.
- (i) Material shall be used by the receiving Party with prudence and appropriate caution.
 - (ii) The sending Party provides the Material on an "as is basis" without any warranty of merchantability, fitness for a particular purpose, utility, efficacy, non-toxicity or safety, or any other warranty, express or implied. The sending Party makes no representation that receiving Party's use of the material will not infringe a patent or other proprietary right of a third party.
 - (iii) The receiving Party may use the Material and results therefrom only during the course of the Project and for the Project, and only under the supervision of the receiving Party's Principal Investigator on the receiving Party's facilities.
 - (iv) Each Party represents that it will obtain the approval of its institutional ethics review board where applicable. Unless specified or agreed in writing, the receiving Party may not use the Material and results therefrom in humans, including for purposes of diagnostic testing.
- 6.2 Material created or developed jointly by the Parties under the Project will be owned jointly by the Parties.
- 6.3 Research Results from Material provided under this Section 5 shall be shared by the Parties who each shall have an unrestricted right to use such research results for its own internal research and teaching purposes during and after this Agreement.
- 6.4 This Section 5 may be superseded by a separate Material Transfer Agreement if Material is subject to different or additional terms and conditions.

7. EXPORT CONTROL

The Parties are responsible for conducting a thorough review of the Project to determine whether and how the Project is impacted by relevant governmental export regulations. Prior to commencing any research activities, the Parties are responsible for reviewing their respective research activities to determine whether their research is potentially subject to any national or international governmental export control regulations; re-evaluating export control determinations before changing the scope or adding new personnel to the Project in order to ascertain whether such changes alter the initial determinations; and obtaining applicable export control determinations far enough in advance to obtain an authorization, should one be required. Each Party shall be responsible for obtaining the required authorizations for conducting an export or re-export of Items to the other Party.

Each Party shall reasonably cooperate with and exercise reasonable efforts to support the other Party in obtaining any necessary export or re-export licenses or authorizations. If either Party provides the other Party with any export controlled items requiring compliance with an export license, the sending Party will notify and provide appropriate written instructions (e.g., Commerce Control List designations, reasons for control, countries for which an export license is required) to the receiving Party's Contractual Contact (as named on Authorized Contacts List). The receiving Party shall not be required to take any action for which it has not received express written instruction

from the sending Party. The sending Party shall provide instructions on items to be sent in conjunction with this Project, and in particular shall provide the applicable export classification numbers.

8. CONFIDENTIALITY

Each Party shall disclose their Confidential Information to the other Party in writing, marked “Confidential.” If Confidential Information is provided orally, visually or in another non-tangible form, the Confidential Information will be reduced to written form, marked “Confidential”, and submitted to the receiving party within ten (10) days of the disclosure. The receiving Party shall a) use reasonable means to protect the confidentiality of Confidential Information, which are at least as diligent as the means used to safeguard its own Confidential Information; b) use such Confidential Information solely for the purpose of carrying out the Project; and c) not disclose such Confidential Information to any third party except authorized representatives of a Party who have a need to know and are engaged to assist in carrying out the Project and who are bound by confidentiality obligations at least as restrictive as those contained herein.

Specifically excepted from Confidential Information is all information that is: (a) known by the receiving Party at the time of disclosure without an obligation of confidence; (b) publicly disclosed except by breach of this Agreement; (c) rightfully received by the receiving Party from a third party without an express obligation of confidence; (d) independently developed by the employees or agents of either Party without any knowledge of the Confidential Information provided by the other Party; or (e) required to be disclosed by law or judicial action. This provision shall remain in effect for a period of 5 years after expiration or termination of the Project.

9. PUBLICATIONS AND PUBLICITY

- 9.1 Each Party shall provide a copy of any proposed publication or presentation to the non-publishing Party's Technology Transfer Contact (as named on Authorized Contacts List in Section B) for review and comment at least thirty (30) days prior to submission to a publisher thereof, or, no later than sixty (60) calendar days before any public disclosure of any Project IP. If the non-publishing party determines that the proposed publication or presentation contains subject matter requiring patent protection or removal of Confidential Information, the publishing party shall delay publication or presentation for up to an additional sixty (60) days to allow the non-publishing Party to preserve or protect its Intellectual Property Rights.
- 9.2 Neither Party will use the other Party's name, insignia, trademark or logo in any press release or product advertising, or for any other promotional purpose, without first obtaining the other's written consent; except that either Party may identify the collaboration for its own internal reporting and compliance purposes. Prior to any public event or activity, Collaborator must submit a request for publicity to marcomhelp@kaust.edu.sa for review and approval by KAUST's Department of Marketing and Communications.
- 9.3 This cooperation agreement will be published as an extract on the Union Official Gazette, according to the pertinent legislation, and the costs of publication shall be Unioeste's responsibility.

10. INTELLECTUAL PROPERTY

- 10.1 Background Intellectual Property. Neither Party will have access or rights to the other Party's Background IP except as set forth in this Section 9.1. KAUST and Collaborator will disclose to each other their respective Background IP that is known to be needed by the other Party for purposes of the Parties' collaboration under this Agreement. Such Background IP is disclosed in the Statement of Work. The absence of disclosure of Background IP in the Statement of Work shall not negate the obligation to subsequently disclose Background IP that is known to be needed by the other Party for purposes of the Parties' collaboration under this Agreement. Each Party grants to the other, for the term of this Agreement, a royalty-free, non-exclusive, non-transferable, non-sublicensable license to use Background IP disclosed under this Section 9.1, solely for purposes of collaborative research under the Project and for no commercial or other purpose.

- 10.2 Project Intellectual Property. As between the Parties, KAUST will solely own Project IP created, conceived, or reduced to practice solely by KAUST or KAUST Personnel (“KAUST IP”); and Collaborator will solely own Project IP created, conceived, or reduced to practice solely by Collaborator or Collaborator Personnel (“Collaborator IP”). The Parties will jointly own Project IP that is created, conceived, or reduced to practice (a) jointly by the Parties; (b) solely by Collaborator or Collaborator Personnel with more than incidental use of KAUST’s facilities; or (c) solely by KAUST or KAUST Personnel with more than incidental use of Collaborator’s facilities (“Joint IP”). Each Party grants the other Party a non-exclusive, royalty-free license, without right to sublicense, to its Project IP solely for the other Party’s internal, non-commercial research and teaching purposes.
- 10.3 Disclosure and Reporting of Project Intellectual Property. Each Party will disclose Project IP to their respective Technology Transfer Contact (as named in Authorized Contact List in Section B) promptly following its creation, conception, or reduction to practice, for up to two (2) years after the Project End Date if arising from the Project. Each Party will deliver copies in English of all Project IP disclosures that it receives, to the other Party no later than thirty (30) calendar days after the date the Party received the particular Project IP disclosure, but in no event later than sixty (60) calendar days before any public disclosure of any such Project IP, including disclosure in a scholarly publication. Each Party will maintain the confidentiality of the Project IP disclosures. This clause shall survive for a period of two (2) years following the expiration or termination of this Agreement.
- 10.4 Management of Joint Intellectual Property. Promptly following receipt of a Project IP disclosure describing Project IP that is Joint IP, the Parties will enter into a written Intellectual Property Management Agreement (“IPMA”) with respect to such Joint IP; provided, however, that the Parties may mutually agree in writing to waive an IPMA for such Joint IP in which case each Party may exercise its lawful ownership right to Joint IP. Prior to execution of an IPMA (unless the Parties have agreed in writing that no IPMA is needed), neither Party may practice, otherwise exploit, make, use, sell, offer to sell, import, license, encumber, and/or otherwise transfer any Joint IP for any purpose unless (a) the other Party consents to such activity in writing; or (b) the purpose is for a Party’s own internal, non-commercial research and education activity.
- Unless otherwise agreed by the Parties on a case-by-case basis, leadership for the evaluation of Joint IP, its protection and the related licensing activities should be attributed either to the institution having contributed most to the Joint IP concerned or to the Party having the best potential to commercialize Joint IP, or to the Party which is the employer of inventor(s) or author(s) willing to develop a start-up company based on such Joint IP. All royalty and licensing income from Joint IP will be shared by KAUST and Collaborator as set forth in the IPMA, taking into consideration each Party’s intellectual, financial, administrative, technology transfer, and other contribution to such Joint IP.
- 10.5 Confirmation of Rights. The Parties will ensure that the Intellectual Property rights of each Party pursuant to this Agreement are acknowledged and complied with by their personnel, students and their collaborators, and each Party will secure from its personnel, students and its collaborators such rights sufficient to fulfill its obligations under this Agreement.

11. RECIPIENTS FOR NOTICES

Unless otherwise specified in this Agreement, any notice to be given under this Agreement shall be in writing and delivered to the other Party at the address and marked for the attention of the Contractual Contact as named in the Authorized Contact List in Section B. All such notices will be served either (i) by hand or by courier (paid by the Party serving the notice) and shall be deemed to have been served when delivered; or (ii) in digital format sent by electronic mail and shall be deemed to be received on the Calendar Day of such transmission.

12. NO WARRANTY

Although the Parties will use reasonable endeavors to carry out the Project in accordance with the Statement of Work, the Parties make no representation that any research will lead to any particular result, nor do they

guarantee a successful outcome to the Project. Neither Party makes any representation or gives any warranty to the other that any advice or information given by it or any of its employees or students who work on the Project, or the content or use of any Project IP, Research Result or Background IP in connection with the Project, will not constitute or result in any infringement of third party rights. Research materials, Background Intellectual Property, Project IP and Research Results are provided by the Parties without any warranty of merchantability or fitness for a particular purpose or any other warranty, express or implied.

13. LIMITATION OF LIABILITY & INDEMNIFICATION

- 13.1 Except for the express undertakings and warranties set forth by the Parties in this Agreement, all other warranties, conditions, terms, undertakings and obligations, whether express or implied by statute, common law, custom, trade usage, course of dealing or in any other way, are excluded to the fullest extent permitted by law.
- 13.2 Neither Party will have liability to the other Party for any claim, loss, damage, or injury incurred under this Agreement or otherwise in connection therewith, other than for each Party's obligations stated in this Agreement.
- 13.3 Neither Party will be liable to the other with respect to any subject matter of the Agreement for special, indirect, incidental, consequential, or punitive damages, or for any lost profit, revenue, data, or opportunity, whether direct or indirect, under any contract, negligence, strict liability or other legal or equitable theory, even if the Party bringing the claim has advised the other of the possibility of those losses, or if they were within the other Party's contemplation.
- 13.4 Each Party will indemnify, hold harmless, and defend the other, and their respective successors and assigns, from and against third party claims, demands, actions, liabilities, damages, and expenses resulting therefrom, arising out of, or related to, the indemnifying Party's negligence or willful misconduct in connection with this Agreement, breach of this Agreement, or non-compliance with applicable law.

14. TERMINATION

Either Party may terminate this Agreement for any reason whatsoever upon thirty (30) days prior written notice to the other Party.

15. SETTLEMENT OF DISPUTES

- 15.1 The Parties shall act in good faith to amicably resolve any dispute between them. The Party raising a dispute shall promptly provide notice to the other Party in a writing that describes in reasonable detail the nature of the dispute. Within 21 days after the recipient has received such notice, each Party shall select for itself a representative with the authority to bind such Party, and shall advise the other Party in writing of the name and title of such representative. The representatives of the Parties shall meet as soon as practicable and make good faith attempts to resolve the dispute. Any dispute not resolved within 90 days after date of claim shall be submitted to binding arbitration.
- 15.2 Any dispute, controversy or claim arising out of or relating to construction, performance or breach of this Agreement that is not settled by the Parties in accordance with Section 15.1, shall be referred to binding arbitration for final resolution under the CEDR Rules (the "Rules"), which Rules are deemed to be incorporated by reference into this clause. The tribunal shall consist of three (3) arbitrators. Each Party shall be entitled to nominate an arbitrator. The third arbitrator, who shall act as chairman of the tribunal, shall be nominated by the two arbitrators nominated by or on behalf of the Parties, and if he is not so nominated within 30 days of the date of nomination of the later of the two party-nominated arbitrators to be nominated, he shall be chosen by the CEDR. The seat of the arbitration shall be London and the language of the arbitration shall be English.

16. GOVERNING LAW

This Agreement is made under and shall be construed according to the laws of the Kingdom of Saudi Arabia, without reference to conflicts of law provisions or principles.

17. EVENTS OF FORCE MAJEURE

Neither Party shall have any liability or be deemed to be in breach of this Agreement for any delays or failures in performance of this Agreement that result from any event of Force Majeure. The Party affected by an event of Force Majeure shall promptly notify the other Party in writing when such circumstances cause a delay or failure in performance and when they cease to do so.

If a Party is prevented from performing a material obligation under this Agreement by any event of Force Majeure for a continuous period of 90 days or more, then the other Party shall be entitled to either suspend or terminate this Agreement with immediate effect by giving notice in writing. Neither Party shall be liable to the other for such suspension or termination. If a Force Majeure event affects the Project for more than 90 days, KAUST may decide, at its sole discretion, to issue a no-cost extension to the Collaborator in justified circumstances.

18. SURVIVABILITY

All provisions of this Agreement, or any IPMA, patent or patent application in place, that by their terms require any performance following termination or expiration of this Agreement shall survive such termination or expiration.

19. SEVERABILITY

Should any term of the Agreement be determined to be unlawful by a court of law or adjudicative body with jurisdiction over the Parties, the remaining terms and conditions of the Agreement shall continue to remain in force and effect and shall be interpreted so as to give the best effect to the original intentions of the Parties.

20. ASSIGNMENT

The Parties agree that this Agreement is a project for collaborative research carried out by KAUST and Collaborator key personnel and is not assignable, whether by operation of law or otherwise, in whole or in part without the prior express written consent of the other Party. Assistance provided to and under the direction and control of the Parties' key personnel by students and laboratory personnel shall not be considered assignments. Wrongful assignment shall be a material breach of this Agreement. Delegation of rights under this Agreement shall be subject to the same procedure and consequences as assignment.

21. NO AGENCY

Collaborator shall be treated as an independent contractor for the purposes of this Project. Nothing in this Agreement shall constitute a partnership or joint venture or establish a relationship of agency between KAUST and Collaborator. No employee of KAUST or Collaborator shall be considered to be an employee of the other, and neither KAUST nor Collaborator shall enter into any contract or agreement with a third party that purports to obligate or bind the other. Neither Party has any authority to make any representation or commitment, or to incur any liability, on behalf of the other.

22. WAIVER OF RIGHTS

If a Party fails to enforce, or delays in enforcing, an obligation of the other Party, or fails to exercise, or delays in exercising, a right under this Agreement, that failure or delay will not affect its right to enforce that obligation or constitute a waiver of that right. Any waiver of any provision of this Agreement will not, unless expressly stated to the contrary, constitute a waiver of that provision on a future occasion.

23. COORDINATOR, FISCAL AND MANAGER

In compliance with Unioeste Service Instruction No. 003/2022 - PRAF, is designated as coordinator of this agreement Professor Edson Antonio da Silva, and as supervisor and manager of this agreement the International Officer Prof. Dr. Rafael Mattiello.

24. LANGUAGE

This Agreement shall be executed in English and Portuguese. In case of any inconsistencies between the two language versions, the terms of the English Agreement will take precedence. All progress reports shall be in English.

- End of Schedule B. Terms and Conditions -

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## Schedule C - Statement of Work

**Project Title:** *Preparation and characterization of biochar derived from various feedstocks, pyrolytic conditions, and chemical activation for aridland greening/agriculture efforts*

### Background

Professor Silva is a renowned expert in biomass pyrolysis, reactor design, and characterizing ion adsorption/exchange in porous media (experiments and modeling). Therefore, his group's know-how and capabilities will help us in laying a solid foundation for scalable production of date palm biochar pyrolysis and quantifying ion-exchange capacities for  $\text{NH}_4^+$  and  $\text{PO}_3^{3-}$  ions. We expect this collaboration to propel the development of biochar blends for precision aridland greening, agriculture, and carbon capture in the Kingdom of Saudi Arabia and beyond.

Prof. da Silva's has a unique expertise in reactor design, modeling chemical reactions, ion adsorption in porous media, supercritical fluids, and modeling chemical reactions that he has gained over the past two decades. If we start this research at KAUST, from scratch, we would be re-inventing the wheel; therefore, this collaboration will expedite our progress. Specific goals include:

- (i) Insights into reactors' multiparametric space to increase energy and reaction efficiency to scale-up.
- (ii) Pinpoint the factors and mechanisms responsible for anion/cation exchange capacity of biochar as a function of feedstock, pyrolysis conditions, and surface treatment.
- (iii) Prof. Silva's laboratory is located in a major global agro-industrial hub, where other sources of waste biomass are available. This presents an excellent opportunity to test the potential of our reactor technology for the Brazilian market.

We had proposed the development of reactors for biochar and Superhydrophobic Sand in our latest RTG application (Fall, 2021). Based on the reviews, we were advised to remove biochar and focus solely on scaling up Superhydrophobic Sand. Following the success of basic research on biochar (materials and reactors) through the proposed collaboration, we plan to submit an RTG application on biochar in the future.

During 2021–2022, we built three batch-scale pyrolysis reactors at KAUST and produced over 2 tons of date palms biochar. Insights from the proposed collaboration will guide reactor development at KAUST.

### KAUST Tasks and Responsibilities

Furthermore, PI Mishra's team will develop protocols for the chemical activation of biochar towards achieve ultrahigh cation exchange capacity (CEC); samples will be analyzed both at KAUST and Co-PI Silva's lab. Rapid greenhouse studies and extensive field trials will be conducted on a variety of crops, trees and shrubs to assess soil amendment and carbon sequestration. With KAUST's extraordinary suite of imaging and characterization tools, we will also try to peer into molecular details of biochar for complementary insights. KAUST team will strive to realize surface treatments that will minimize the loss of stabilized biochar matter in the soil, i.e., to maximize carbon sequestration.

| KAUST Workplan: |                                                                 |      |         |
|-----------------|-----------------------------------------------------------------|------|---------|
| Activities:     |                                                                 | Year | Quarter |
| 1.              | Enhancement of biochar CEC                                      | 1-2  | 1-4     |
| 2.              | Biochar activation with nutrient rich solutions                 | 1-2  | 1-4     |
| 3.              | Greenhouse and field tests of raw, washed and enriched biochars | 1-3  | 4       |
| 4.              | Continuous and batch reactor development                        | 1-3  | 4       |

| <b>Deliverables:</b> |                                                                                        | <b>Year</b> | <b>Quarter</b> |
|----------------------|----------------------------------------------------------------------------------------|-------------|----------------|
| 1.                   | Manuscript on ultrahigh CEC biochar                                                    | 1           | 4              |
| 2.                   | Manuscript on the applications of biochars for amending soils in aridland agriculture  | 2           | 4              |
| 3.                   | Development of optimized pyrolysis reactor for processing of date palm residue biomass | 3           | 4              |

## Objectives:

- Model the effects of feedstock, temperature, and time on heat transfer, chemical reactions (slow/fast pyrolysis) to develop energy-efficient scalable reactors.
- Enhance biochar CEC without compromising its longevity in the soil
- Pinpoint factors and mechanisms underlying ion adsorption on biochar surface.
- Understand the benefits of biochar in arid-land soils.

We expect to have a few manuscripts on the production of enhanced CEC biochar, the use of different blends of biochar for field trials in KSA, the activation/ad of biochar with multiple ions. The knowledge on the above-mentioned experiments, modeling and methodologies will be transferred to KAUST in the form of yearly reports, presentations and jointly written manuscripts.

### UNIOESTE Tasks and Responsibilities

UNIOESTE will perform experimental and computational study of pyrolysis of a variety of biomass feedstocks to understand reaction kinetics and heat transfer as a function of reactor conditions and configurations. Additionally, they will study adsorption of ions, zwitterions, and bio-stimulants on the various blends of biochar (experiment and modelling).

| <b>UNIOESTE Workplan:</b> |                                                                                       |             |                |
|---------------------------|---------------------------------------------------------------------------------------|-------------|----------------|
| <b>Activities:</b>        |                                                                                       | <b>Year</b> | <b>Quarter</b> |
| 1.                        | Reactors design and optimization of heat transfer and kinetics                        | 1-2         | 4              |
| 2.                        | Study of pyrolysis conditions, reaction rates and modelling                           | 2-3         | 4              |
| 3.                        | Study of adsorption/desorption of molecules and ions of interest into biochars        | 2-3         | 4              |
| <b>Deliverables:</b>      |                                                                                       | <b>Year</b> | <b>Quarter</b> |
| 1.                        | Manuscript/report/presentations with the main findings for respective year activities | 1           | 4              |
| 2.                        | Manuscript/report/presentations with the main findings for respective year activities | 2           | 4              |
| 3.                        | Manuscript/report/presentations with the main findings for respective year activities | 3           | 4              |

| <b>UNIOESTE REQUESTED RESOURCES: (breakdown of costs)</b> |                                                                                        |  | <b>US\$</b>        |
|-----------------------------------------------------------|----------------------------------------------------------------------------------------|--|--------------------|
| <b>Item</b>                                               | <b>Description</b>                                                                     |  |                    |
| #1 PhD student stipend                                    | Support for one PhD student to conduct the research (~2900 BRL/month for 3 years)      |  | 22,000             |
| #2 Master's student stipend                               | Support for one Master's student to conduct the research (~1875 BRL/month for 2 years) |  | 9,700              |
| #3 Master's student stipend                               | Support for one Master's student to conduct the research (~1875 BRL/month for 2 years) |  | 9,700              |
| Miscellaneous                                             | Materials, reactants and miscellaneous expenses                                        |  | 8,600              |
| <b>*TOTAL:</b>                                            |                                                                                        |  | <b>US\$ 50,000</b> |