PROJECT TITLE: The anticipated costs and environmental impacts of centralized and decentralized rice straw bioenergy and bioash production

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COOPERATORS:

N/A

LEVEL OF 2022 FUNDING: $31,837

OBJECTIVES AND EXPERIMENTS CONDUCTED, BY LOCATION, TO ACCOMPLISH OBJECTIVES:
The objectives of this work are outlined below:

Objective 1: Develop inventories to facilitate cost and environmental impact comparisons

Objective 2: Assess economic and environmental impacts

Objective 3: Determine thresholds for producing rice straw ash to contribute to cost and environmental benefits.

These objectives were performed in conjunction with ongoing funding (Title: The effects of post-pyrolysis treatments on the properties of rice straw for use in cement-based materials; Start date: April 2022, End date: Dec 2023; Level of funding: $28,905). The objective of this work was to assess two means for improving consistency of rice straw ashes (RSA) as mineral additives. These means were: (1) the effects of grinding the ashes; and (2) improving consistency by blending the RSAs with other mineral additives.

All experiments and/or analyses done to accomplish these objectives were performed on the University of California, Davis campus, with the exception of some discussions, which were administered off-campus or via remote conferencing. To complete some of the proposed work, ash samples will be sent to an analytical facility off-campus to determine oxide composition in a timely manner.

SUMMARY OF 2022 RESEARCH (major accomplishments), BY OBJECTIVE:

Life cycle economic and environmental impact assessments were performed to assess potential benefits of rice straw ash as a partial replacement for cement in concrete. Research is still underway, but to date, the following major accomplishments have been made by objective:

Objective 1: We quantified different cost inputs, different materials, energy, and waste flows of producing rice straw ash.

Objective 2: We used these inventories to determine economic and environmental impacts of the key processes. These processes included those such as leaching, drying, reverse osmosis, transportation of biomass, combustion of biomass (with and without energy production).

Objective 3: As we refine data inputs, through mechanisms such as additional discussions with stakeholders and sensitivity assessments, we will determine thresholds for processes that will result in favorable economic and environmental impacts.

PUBLICATIONS OR REPORTS:

A report will be compiled summarizing the work done and the findings from this research. It is also anticipated that at least one peer-reviewed publication will result from this research.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Findings to date suggest that preparing rice straw for combustion to derive the ash as a mineral additivity for concrete has notable impact. From an economic perspective, both capital and operating costs are high. Our preliminary estimates put these at approximately $300,000 and $170,000, respectively, for a rice straw ash recovery from a 200-acre rice farm. However, total revenue from ash and fertilizer that could be recovered was estimated at less than $10,000 annually for the same size farm. For greenhouse gas (GHG) emissions from producing rice straw

ash, impact was just under break even with electricity and cement replacement. Much of the cost and GHG emissions were derived from diesel fuel (for drying front loader, and transportation of straw, brine, and sludge), so alternatives may be beneficial; additionally, water pumping resulted in the highest impact within the leaching process, but this was sensitive to shifts in how water retrieval was modeled. Overall, the logistical issues of high water demand for leaching and the need for appropriate space (or if cycles of leaching are performed instead of leaching in one batch, then appropriate space and time) are challenging.