'Ricing' up to the Challenge

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'NEW problems call for new solutions. Well, a problem may not be new per se, but just something which was swept beneath the carpet for a long time, only to emerge more conspicuously...demanding immediate attention. And often, it takes several new solutions to combat one such 'emergent' problem. This article, which is inspired by laboratory work carried out by the first author at TERI, New Delhi (and based on a published study, "Characterising Rice Straw Ash: Unlocking the Potential of Agricultural Residues". *Studia Ecologiae et Bioethicae*, 2024), is an addition to circular-bioeconomy literature, which, while focusing on addressing a primary concern, will be able to provide solutions to many others.

A soil-to-soil circularity paradigm, while contributing to soil fertility and food security, also mitigates air pollution and climate change-related concerns. The 'lynchpin' here is rice straw — agro-wastes/residues, which is generated in huge quantities every year, and stubble burning in fields is the 'hotspot process' which needs to be reigned in. The status quo makes one look upon it (and many other such agro-residues) as a villain, while this article reveals (as some others have done before) that if looked upon as a resource, packed with nutrients, macro-and micro. It emerges as an abundantly generated valorisable residue. As the year 2030 approaches, advances made towards the Sustainable Development Goals (SDGs) will speed up. The illustration throws light on the relationships among the 'enabling SDGs' and the 'enabled SDGs'. The final product, which wends its way back to the soil, to which it owes its origin in the first place, is Rice Straw Ash (RSA).

SDG 17 mandates collaboration among the stakeholders who figure in the valorisation/conversion chain — farmers, policymakers, researchers, and industries in the agriculture, energy, and environmental sectors. While the lab studies referred to focused on rice straw (and the characterisation of the ash derived therefrom) as the starting material, it can be reiterated at this juncture that agro-residues in general must be looked upon as valuable resources. These residues, also termed stubble, have been traditionally subjected to open burning in fields in India, and the consequences are well-known to all — release of harmful Particulate Matter (PM2.5 and PM10), carbon dioxide, methane, and other toxic pollutants, worsening India's already critical air quality.

Rice straw ash contains potassium oxide and silicon dioxide (or silica), inter alia, the latter being abundant in soils and known to be a biological stimulant, but becoming deficient over time. One must not forget that arable soils are not necessarily renewable, but 'fund resources' which need to be maintained and managed in order to ensure that their

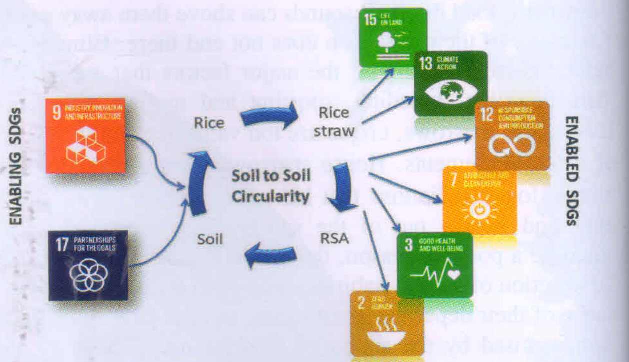

Figure 1: Illustrating the interdependence between enabling SDGs and enabled SDGs

utility is durable. RSA, thus, may very well play a key role in sustaining the fertility and cultivability of arable soils in India. And all that we have to do here is to recirculate what came from the soil back to the soil, through a series of processes, players and policies.

Pusa Basmati — the focus of the lab study

The first author worked with samples of rice straw of *Pusa Basmati* (PB 1121) collected from the Indian Agricultural Research Institute (IARI) in New Delhi. The methods adopted are not detailed in this article, but readers may be interested in referring to the journal paper cited. However, another set of photographs from the said journal paper has been reproduced in Figure 2. Table 1 tabulates the different characterisation techniques and the purposes for which they were adopted.

The chemical composition of the RSA, determined using electron probe microanalysis, revealed the following concentration profile: carbon, held in lignin, hemicellulose and cellulose (0.7%), nitrogen (1%), magnesium (3.2%), silicon (37.4%) and calcium (6%). The chemical composition of RSA is testimony to the promise it holds as a soil amendment agent.

Figure 2: Clockwise from top, muffle furnace set at 700°C, the dried rice straw (RS) sample and the rice straw ash (RSA)