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Climate resilience through management of energy potential of crop residue

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Introduction

The majority of the land is used for agriculture, and a wide variety of crops are grown in the various agro-ecological zones of India. The farmers of totally depend on the quality and productivity of the plant diversity in agriculture cropping systems, but they are facing uncertainty regarding sustainability of natural resources (forests, wildlife, water, coal energy and petroleum), socio-economic status and climate change impacts (Devi et al., 2017). In farm land, crop residues like rice, wheat, cotton, maize, millet, sugarcane and jute are mostly burnt on-farm in several states of India. The total contribution of cereal crops (rice, wheat, maize, millets) is 70% while only rice variety contributes 34% of the crop residues (Pachauri et al., 2022). The main cause of degradation of agricultural land is less soil-carbon content and increasing the level of green house gases (GHGs) due to burning of crop residue. The remaining residues are left unused or burnt on farm through farmers, mostly in Punjab, Uttar Pradesh, and Haryana. It directly impacts on upper most layer of soil, increasing soil quality depletion (loss of soil nutrients like C, P, N) and effects on climatic factors as well as ecosystem services.

In India, huge volumes of crop residues are produced both on-farm and off-farm, estimated at approximately 500-550 Mt of crop residues produced per year in the country. These crop residues are used for livestock feed, soil water retention, organic fertiliser making, thatching for villagers and bioenergy production. “Crop residue is plant material from crops that can be used to generate energy for domestic and industrial use”. As per the Ministry of New and Renewable Energy, Government of India, a total of 288 biomass power and cogeneration projects aggregating to 2665 MW capacity have been installed in the country for feeding power to the grid (Hiloidhari et al.,

2014). The common biomass crop residue includes sugarcane bagasse, rice husk, straw, cotton stalk, coconut shells, soya husk, coffee waste, jute waste, groundnut shells, sawdust, *etc.*, for power generation in India. Crop plantation has a significant role in CO_2 mitigation and sequestering carbon in both plants and soil, which is also helpful to policy recommendations in ecosystem sustainable development as well as farmer's needs. In this, the farm crop residues are managed inside the farm itself and also done by different processes, which improve the soil structure, reduce the intensity of weeds and improve the productivity.

Crop residue scenario

- **Early agriculture -** After harvesting, crop residue burnt in farm land area
- **Green revolution -** High crop production by management practice of crop residue
- **Environment awareness-** Highlight sustainability of resources through pattern of crop residue utilization
- **Climate change (currently)-** Production of bioenergy via processing of crop residue practice

Climate resilience by energy potential crop residue management

- **Residue incorporation-** The crop residues are incorporated completely or partially into the soil, mostly by ploughing method
- **Mulching-** Increase surface water retention, reducing leaching and evapotranspiration by process of mulching
- **Livestock-** Use as animal feeding and wheat straw are typically used as bedding materials for animals.
- **Bioenergy production-** Crop residue biomass can be efficiently utilized as a source of energy example are rice, wheat, maize
- **Thermochemical transformation-** Production of energy involves three processes: gasification (a partially oxidation process), pyrolysis

(thermal decomposition absence of oxygen) and liquefaction (production of bio-oil from crop residue

- **Biochemical transformation**- This process involves some specific yeast and bacteria to transform the residue into useful energy).
- **Pusa decomposer**-Recently, a bio-decomposing capsule, named as 'Pusa decomposer, convert crop residue into compost developed by Dr Livleen Shukhar.
- **Mushroom production**-Agro-waste crop residues like rice and wheat straw, saw dust, rice bran used for mushroom production.
- **Transport**- Baling and transporting the crop residues from the field for safe disposal is feasible only when alternate, effective and economically viable usage methods are identified.
- **Awareness**- Appropriate policy interventions for crop residues management is formulated by National Policy for Management of Crop Residue
- **Miscellaneous uses**- Different type value-added products can be made by crop residue to generate income (Paper from paddy straw).

The total Chir Pine Forest area is covered by 16.36% in the forest of Uttarakhand (Arya and Sijwali, 2022). Chir pine has also a negative impact as dry leaves (known as pirul) fall in large quantities and decompose very slowly due to their acidic nature, a major cause of fire threat in the Pine Forest of Uttarakhand. Due to its excellent burning capacity, the Uttarakhand government has established a 25-kilowatt power plant in the Chakori Dhanari village of the Uttarkashi district. The pirul has been traditionally utilised to make beds for domestic animals, as a fertilizer production, handmade paper, and under the Pirul Lao-Paise Pao campaign 2024, the locals and villagers collect dry pirul (pine needles) to maintain in the forest. In Uttarakhand, bioenergy crop residue is not burnt immensely; it is mostly used as fodder, promotes the organic carbon sequestration in the soil to regulate the ecosystem cycle and assesses the benefit: cost and environmental impact of residue retention/incorporation in conservation biofuel. The analysis of bioenergy production impact based on survey aspects and their source is storable, inexpensive, energy-efficient and environmentally friendly. In perspective, it plays a role in the production of second-

generation biofuels, thus supporting the decarbonisation in the transport sector without threatening food security or impacting land use *via* crop residue management practices.

Conclusion

The management practices of bioenergy crop residue to enhance soil productivity may facilitate more stable and longer-term stability of carbon and net balance between these inputs and outputs of potential environmental, social and economic aspects. The gradual change in the energy mix, replacing fossil fuels with renewable energy sources, is one of the principal ways to mitigate greenhouse gas (GHGs) emissions.

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