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Non-Conventional Soil Amendments to Improve Soil Fertility and Crop Productivity

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By 2050, India's population (1.74 billion) will require around 350 mt of food grains. Most Indian soils have low to medium SOC (Soil Organic Carbon), which limits nutrient use efficiency and benefit cost ratio in cropping systems. While SOC can be improved through crop residues, vermicompost, green manure and FYM, but declining availability of FYM and reliance on chemical fertilizers are causing reduced yields and soil fertility decline. Among these, press mud (PM), a sugar industry by-product, is rich in organic carbon and essential plant nutrients. In India, about 11.4 mt of press mud is generated annually, offering a potential resource to enhance soil organic carbon (SOC) and nutrient availability. Biochar, derived from pyrolyzed biomass, has emerged as a promising amendment for improving soil fertility. Its application enhances soil moisture retention, nutrient availability, microbial biomass and carbon sequestration, while also offering a climate change mitigation strategy through carbon-negative energy production. Phosphogypsum, a by-product of the phosphoric acid industry, is an important source of readily available sulphur, calcium and phosphorus. Unlike elemental sulphur, which requires microbial oxidation, phosphogypsum supplies sulphur in sulphate form, making it immediately available to crops. Other industrial and agro-based by-products such as paper mill sludge, fly ash and sewage sludge also serve as valuable non-conventional amendments. These materials not only recycle waste but also contribute to soil fertility restoration, improved nutrient dynamics and sustainable crop production. Thus, the strategic utilization of such non-conventional amendments not only addresses waste management and environmental concerns but also offers a pathway for enhancing soil health and sustaining crop productivity in the long run.

What are Non-conventional soil amendments?

- Soil amendments are materials added to soil to improve its physical, chemical and biological properties to enhance plant growth.
- Non-conventional soil amendments are organic or inorganic by-products and industrial wastes that are not traditionally used in farming but, when applied to soil, improve its properties while supplying essential nutrients for crop growth.

Examples: Biochar, Press mud and Paper mill sludge

Why to choose non-conventional soil amendments:

Enhance soil properties, beyond nutrients

- Some non-conventional amendments like biochar, press mud etc. improve soil physical properties (water retention, aeration), chemical properties (pH buffering) and biological activity more effectively than FYM or vermicompost alone.

Diversity of nutrient sources:

- Conventional amendments like FYM and vermicompost primarily supply macro-nutrients but may lack or be deficient in certain micro-nutrients and secondary nutrients.
- Non-conventional amendments (e.g., rock dust, industrial by-products) can supply a broader spectrum of nutrients needed for balanced crop growth.

Remediation of problematic soils:

- Non-conventional amendments are often better suited for remediation of degraded soils by immobilizing heavy metals or improving soil chemistry.

Mechanisms by which non-conventional soil amendments improve soil fertility

- ✓ **Nutrient supply & slow Release**: Gradual release of nutrients ensures long-term plant availability and minimizes losses.
- ✓ **Organic matter addition:** Adds carbon sources and enhances soil organic carbon levels.
- ✓ **Soil physical improvement**: Enhances aggregation, reduces bulk density, and increases aeration and water infiltration.
- ✓ **Microbial stimulation**: Encourages growth of beneficial microbes, crucial for nutrient transformation and soil health.
- ✓ **pH buffering:** Neutralizes acidic or alkaline soils, enhancing nutrient solubility and reducing ion toxicity (e.g., Al^{3+}, Na^{+}).
- ✓ **Contaminant immobilization**: Binds or stabilizes heavy metals and other pollutants, reducing bioavailability and uptake by plants.

BIOCHAR

Biochar is a fine-grained, carbon-rich, porous and stable charcoal like substance obtained after plant biomass has been subjected to pyrolysis (thermal decomposition at temp. 350-600^{0}C in an environment with little or no oxygen.) such as:

- Crop residues (e.g., paddy husk, groundnut shell, sugarcane trash)
- Forestry waste (e.g., wood chips)
- Agro-industrial waste (e.g., coconut shell, pressmud)

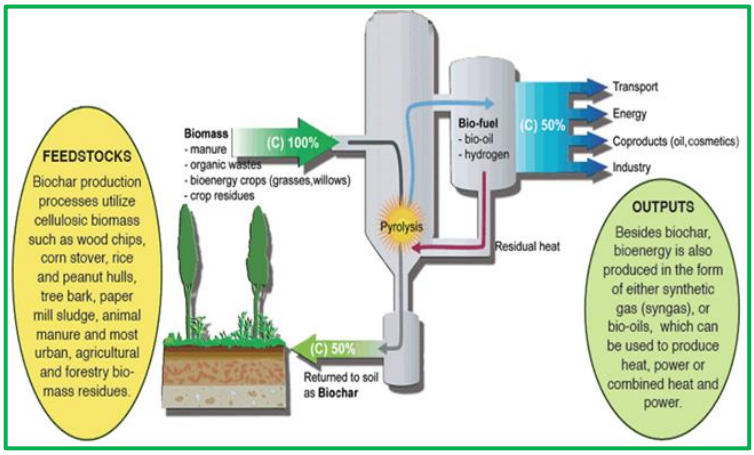

Fig. 1: Biochar production process and outputs through pyrolysis of feedstocks

PRESS MUD

Press mud, also known as filter cake or sugarcane scum, is a solid waste generated during clarification and filtration of sugarcane juice in the sugar manufacturing process in sugar industries.

- ❖ Press mud collected from vacuum filters is treated with lime and sulfur dioxide to remove impurities.

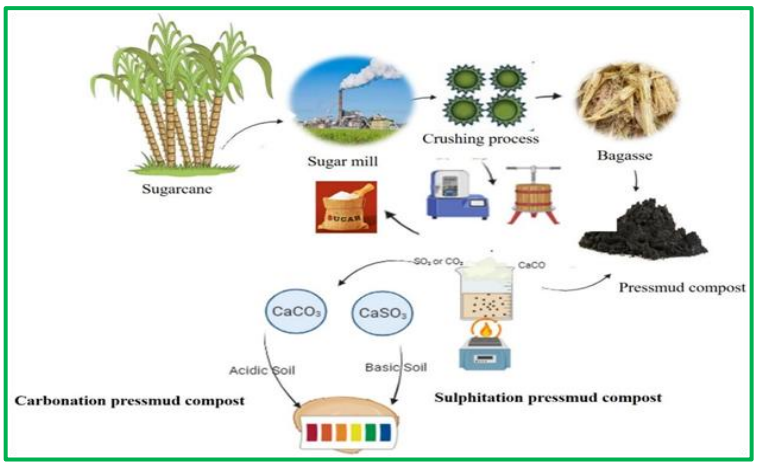

Fig. 2: Process of formation of sugarcane to pressmud compost

PAPER MILL SLUDGE

It is a by-product from treating water in pulp and paper manufacturing plants.

Types:

- **Primary sludge**: mainly wood fibers and fillers.
- **Secondary sludge**: largely dead microbial biomass from biological treatment.

➢ Pulp and paper industry produces millions of tonnes of sludge annually worldwide, posing disposal challenges.

Application Methods:

- Composting/Vermicomposting: Stabilizes sludge, reduces pathogens, and improves safety and nutrient content.
- Direct land application: Requires careful rate calculation and monitoring, especially regarding heavy metals.
- Integrated Nutrient Management

Compositions of different amendments

Nutrients / Components	Biochar	Press mud	Phospho gypsum	Fly ash	Spent mushroom substrate	Paper mill sludge
Carbon (C)	40-80%	30-40%	Negligible	<1%	40-60%	Organic fibers
Nitrogen (N)	0.1-1.5%	1-2%	<0.01%	<0.1%	1-3%	0.5-1.5%
Phosphorus (P_2O_5)	0.1-1.0%	0.5-1.2%	0.05-0.3%	<0.1%	0.3-1.0%	0.2-0.5%
Potassium (K_2O)	0.3-3.0%	0.7-1.5%	Negligible	0.1-0.3%	0.5-1.5%	0.1-0.4%
Sulfur (S)	0.1-1.0%	0.2-0.5%	16-18% *	0.3-0.8%	0.1-0.4%	0.05-0.2%
Calcium (Ca)	1-10%	1.5-4.0%	18-20%	10-20% (CaO)	0.5-3.0%	10-30% ($CaCO_3$)
pH	7-10	5.5-7.5	2-4	8-12	6.5-7.5	6-8
EC (dS/m)	0.5-3	1-4	<1	0.5-3	1-3	0.5-2

Precautions for use of non-conventional soil amendments

Quality & contamination control:

- Test for heavy metals, pathogens and toxic compounds.
- Use only treated/stabilized materials (e.g., composted sludge, processed fly ash).

Application rates:

- Apply in recommended doses to avoid nutrient imbalance or salt buildup.
- Follow regulations and safety guidelines.

Environmental monitoring:

- Monitor soil and crop health regularly.
- Prevent runoff or leaching into nearby water sources.

Avoid untreated waste:

- Never apply raw sewage sludge or fresh industrial waste to avoid contamination risks.

Site-specific use:

- Choose amendments based on soil type, crop requirements and local conditions.

References

1. Karthik A, Duraisamy V K and Prakash A H, 2019. Influence of different biochars on growth, yield and quality of cotton (*Gossypium hirsutum* L.). *International Journal of Current Microbiology and Applied Sciences*, 8(7): 757–764.
2. Maheshwari B, 2022, Residual effect of biochar on yield of chickpea and soil proprties grown after maize in *vertisol*. M.Sc. (Agri.) Thesis, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

3. Ram B, Chouhan S, Kumar R, Kumari S, Priyadarshi R and Sinha S, 2024. Enhancing soil fertility in calcareous soil through sulphitated press mud (SPM), Trichoderma viride and biofertilizer integration in sugarcane (*Saccharum officinarum* L.). *Journal of Eco-friendly Agriculture*, 19: 417–423.
4. Vaishnav S, Ananda M R, Rehaman H M, Seenappa C and Prakasha H C, 2023. Response of groundnut (*Arachis hypogaea* L.) to different levels and time of phosphogypsum nutrition. *Legume Research - An International Journal*, 46(1): 100–103.