

5. CIRCULAR ECONOMY IN INDIAN AGRICULTURE

India is increasingly emphasizing circular economy principles in agriculture to address environmental degradation, resource inefficiency, and rural income instability. The transition from a linear “produce–consume–dispose” model to a reuse–recycle–regenerate framework is central to sustainable agricultural transformation.

Circular Economy in Indian Agriculture – Waste-to-Wealth Transformation

By 2050, India’s circular economy is projected to reach \$2 trillion in market value and generate nearly 10 million jobs, indicating its macroeconomic significance.

I. Conceptual Framework

Circular Economy in Agriculture

1. A regenerative system where agricultural by-products and waste are reintegrated into production cycles.
2. Focuses on minimizing external inputs and reducing environmental externalities.
3. Converts crop residues, livestock waste, and agro-industrial by-products into bioenergy, compost, and bio-based inputs.

Waste-to-Wealth Approach

1. Transforms agricultural waste into economic assets such as –
 1. Bio-CNG
 2. Compost and biofertilisers
 3. Biomass-based power
 4. Industrial raw materials
2. Aligns environmental sustainability with income diversification for farmers.

II. Scale and Potential of Agricultural Waste in India

Magnitude of Agricultural Residue

1. India generates approximately 350 million tonnes of agricultural waste annually.
2. Includes paddy straw, wheat straw, sugarcane bagasse, husk, and livestock waste.

Energy Potential

1. Estimated capacity to generate over 18,000 MW of power annually if residues are efficiently utilized.
2. Significant potential for decentralized renewable energy generation in rural areas.

III. Circular Agricultural Practices

Crop Residue Management

1. In-situ methods – Mulching, soil incorporation, conservation agriculture.
2. Ex-situ methods – Composting, biomass-based energy generation.
3. Reduces stubble burning and associated air pollution.

Integrated Farming Systems

1. Interlinking crops, livestock, fisheries, and agroforestry.
2. Enhances nutrient cycling and risk diversification.

Organic Manure and Biofertilisers

1. Conversion of cattle dung and biomass into compost and biogas slurry.
2. Reduces dependency on synthetic fertilizers.

Water Recycling and Wastewater Reuse

1. Treated wastewater used for irrigation.
2. Reduces freshwater stress in water-scarce regions.

Agroforestry and Mixed Cropping

1. Improves soil fertility and biodiversity.
2. Enhances carbon sequestration and climate resilience.

IV. Economic and Environmental Benefits

Energy Security

1. Biomass-based bioenergy reduces reliance on fossil fuels.
2. Promotes decentralized renewable energy systems.

Soil Health Improvement

1. Organic inputs enhance microbial activity and soil structure.
2. Reduces long-term degradation caused by chemical-intensive farming.

Pollution Reduction

1. Controls stubble burning and air pollution (notably in Punjab–Haryana belt).
2. Prevents soil and water contamination.

Income Diversification

1. Additional revenue streams from selling compost, bio-CNG, and biomass.
2. Promotes rural entrepreneurship.

SDG Alignment—Supports SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption), SDG 13 (Climate Action).

V. Key Challenges

High Initial Capital Costs

1. Biogas plants and bio-CNG units require significant investment.
2. Small and marginal farmers face financial constraints.

Technological and Skill Gaps

1. Limited awareness about residue management technologies.
2. Improper utilization of machines like Happy Seeder reduces efficiency.

Market Constraints

1. Weak value chains for organic manure and bio-products.
2. Limited assured procurement compared to chemical fertilizers.

Fragmented Landholdings—Small farm sizes (particularly in eastern India) hinder efficient waste aggregation.

Institutional Coordination Gaps—Multiple ministries involved; coordination challenges may affect implementation efficiency.

VI. Government Initiatives Promoting Circularity

• GOBARdhan Scheme

1. Converts cattle dung and crop waste into compressed biogas (CBG) and organic manure.
2. As of January 2026 –
 1. Covered over 51% of districts.
 2. 979 operational biogas plants.

Crop Residue Management (CRM) Scheme

1. Allocated ₹3,926.16 crore (2018–19 to 2025–26).
2. Established over 42,000 Custom Hiring Centres.
3. Distributed 3.24 lakh residue management machines.

Agriculture Infrastructure Fund (AIF)

1. Supports warehouses, cold storage, and primary processing infrastructure.
2. Facilitates organic value chains.

Animal Husbandry Infrastructure Development Fund (AHIDF)

1. ₹15,000 crore corpus under Atmanirbhar Bharat.
2. Supports dairy, feed manufacturing, and waste-to-wealth projects.

Water Reuse Initiatives

1. National Mission for Clean Ganga.
2. Jal Shakti Abhiyan promoting treated wastewater reuse.

VII. Way Forward

Strengthen Financial Inclusion

1. Expand credit access for bioenergy and compost infrastructure.
2. Increase subsidy support for small farmers.

Promote Decentralised Bioenergy Models

1. Scale up village-level biogas units.
2. Integrate with rural livelihood missions.

Improve Technology Dissemination

1. Expand Custom Hiring Centres.
2. Strengthen agricultural extension services.

Build Robust Market Linkages

1. Strengthen Farmer Producer Organizations (FPOs).
2. Ensure branding and certification for organic inputs.

Policy Convergence—Integrate circular agriculture into climate action plans and carbon markets.

Conclusion

Circular agriculture represents a systemic transformation of India's agrarian economy, shifting from waste generation to resource regeneration. By aligning environmental sustainability with economic efficiency, it offers a pathway to –

1. Improve farmer incomes
2. Reduce pollution
3. Enhance soil fertility
4. Strengthen rural energy security

Its long-term success depends on financial viability, technological diffusion, institutional coordination, and market development, ensuring that waste-to-wealth becomes a scalable and inclusive rural development strategy.

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