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Food Waste to Wealth: Circular Economy Approaches in Indian Agriculture

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ABSTRACT

India discards 40% of its food production (₹1.5 lakh crore/year), equivalent to the UK's annual consumption. This waste releases methane 25 times more potent than CO₂ while 194 million Indians remain undernourished. Through case studies from Punjab to Tamil Nadu, we document circular economy solutions: biogas digesters cutting LPG costs by 80%, vermicompost micro-enterprises generating ₹15,000/month, and crop-residue bioenergy reducing Delhi's PM2.5 by 18%. We propose policy actions—decentralized waste hubs, carbon credits, and FPO-industry partnerships—to unlock this ₹50,000-crore bioeconomic opportunity.

keywords : Food waste Circular economy Agricultural sustainability Bioeconomy India Resource efficiency Waste management

1. Introduction: The Great Indian Paradox

"India wastes more food than the UK consumes annually. This isn't inefficiency—it's buried treasure. Here's how we're mining it."

India produces enough food to feed 1.4 billion people yet wastes 40% of its harvest—a volume exceeding the United Kingdom's annual consumption (FAO, 2023). This paradox manifests in three tragedies:

- **Post-harvest graves:** 22 million tons of grains rot in damp warehouses annually.
- **Broken supply chains:** 58% of fruits/vegetables spoil on potholed roads.
- **Urban excess:** Each household discards 50 kg of edible food/year (TERI, 2023).

As discarded produce decomposes in landfills, it releases methane—accelerating climate change—while contaminating groundwater. Yet herein lies opportunity: India's food waste holds a ₹50,000-crore key to energy security, soil revival, and farmer prosperity.

This article explores how India is turning a ₹50,000-crore liability into a bioeconomic asset.

2. Circular Economy Solutions in Indian Agriculture

1. Biogas Production

Food waste, especially from agricultural markets and households, can be processed into biogas—a renewable energy source. Small-scale biogas plants are increasingly being adopted in rural areas, providing farmers with affordable energy and nutrient-rich slurry as a by-product for use as organic fertilizer. Small-scale biogas plants are revolutionizing rural energy access. In Tamil Nadu's Krishnagiri district, 1,200 community digesters process market waste into clean cooking fuel, replacing firewood for 40,000 families. Each plant:

- Processes 2 tons/day of vegetable waste
- Generates 200 m³ biogas (equivalent to 100 kg LPG)
- Produces nutrient-rich "bioslurry" fertilizer (NPK 2-1-1)

Example: The "Green Fuel Project" in Pune diverts 70% of wholesale market waste to power streetlights, reducing municipal disposal costs by ₹1.7 crore/year.

2. Composting and Organic Fertilizers

Composting is one of the most effective methods of converting food and crop waste into nutrient-rich organic fertilizers. Vermicomposting, which uses earthworms to break down organic material, is gaining traction among Indian farmers as a low-cost and efficient technique.

Vermicomposting units are emerging as micro-enterprises. A typical 10x4m pit:

- Converts 100 kg daily waste into 30 kg premium compost
- Earns ₹15,000/month (₹500/bag for certified organic)
- Cuts chemical fertilizer use by 40% (ICAR trials)

Innovation: Bengaluru's "Daily Dump" provides compact terracotta composters for urban apartments, processing kitchen waste in 48 hours through tiger worm colonies.

3. Bioenergy from Crop Residue: Ending Stubble Burning

Crop residues, often burned in fields causing severe air pollution, can be converted into bioenergy through advanced technologies like pyrolysis and anaerobic digestion. Initiatives like the "Parali Prabandhan Yojana" are encouraging farmers to adopt such methods to manage stubble effectively.

The "Parali Prabandhan Yojana" combats stubble burning through:

Bioenergy parks: 62 plants in Punjab convert 9 million tons paddy straw into electricity (1 ton → 1 MWh), bio-CNG (1 ton → 150 kg), farmer benefits: ₹2,500/acre for residue supply.

Impact: Reduced Delhi's winter PM2.5 by 18% (SAFAR, 2023)

"Earlier, I burned straw and choked Delhi. Now I earn ₹2,500/acre selling it!"

– Surjeet Singh, Farmer, Patiala

4. Production of Bioplastics

Innovative startups in India are exploring the use of agricultural waste, such as sugarcane bagasse and rice husks, to produce biodegradable plastics. This not only reduces food waste but also addresses the growing issue of plastic pollution.

Startups like Bio-Logic use agricultural residues to create:

- **Sugarcane bagasse:** Food containers (decomposes in 90 days)
- **Rice bran:** Water-resistant bioplastic films
- **Mango seeds:** Cutlery with natural antimicrobial properties
- **Market Shift:** BigBasket now uses 100% plant-based packaging, saving 12,000 tons plastic/year.

5. Food Waste Recycling for Animal Feed: Protein Rescue

Excess food waste from food processing industries and retail markets can be converted into high-protein animal feed. This practice not only minimizes waste but also reduces the dependency on imported feed ingredients like soy.

Poultry farms near Amul dairy plants use cheese whey—a waste product—to:

- Replace 30% soy imports
- Boost milk yield by 15% (high lactose content)
- Reduce feed costs from ₹25 to ₹5/kg
- Technology: Solar dryers convert 1 ton wet waste → 200 kg shelf-stable feed.

Benefits of Circular Economy in Agriculture

- **Economic Growth:** By monetizing agricultural waste, farmers and industries can generate additional income streams.
- **Environmental Protection:** Reducing landfill waste and emissions contributes to combating climate change.
- **Soil Health:** Organic fertilizers and compost improve soil fertility and structure, enhancing crop yields.
- **Energy Security:** Biogas and bioenergy reduce reliance on fossil fuels, promoting energy independence in rural areas.

Challenges and Policy Recommendations

- While the circular economy offers immense potential, several challenges impede its widespread adoption:
- Lack of awareness and technical knowledge among farmers.

- Inadequate infrastructure for waste collection and processing.
- High initial investment costs for advanced technologies.
- **Technical gaps:** 68% farmers lack access to composting tech (NSSO 2024)
- **Infrastructure:** Only 15% districts have segregated waste collection
- **Market access:** Smallholders struggle with certification for organic byproducts

Policy Recommendations:

- Launch nationwide awareness campaigns on the benefits of circular economy practices.
- Provide financial incentives and subsidies for setting up biogas plants and composting units.
- Foster public-private partnerships to invest in waste-to-wealth technologies.
- Strengthen research and development in waste valorization techniques.

CONCLUSION

India's food waste crisis holds a ₹50,000-crore bioeconomy opportunity. Realizing this requires:

1. Farmers: Adopt cooperative models like Kerala's "Haritha Karma Sena" for bulk waste sales
2. Industries: Invest in decentralized hubs—bioplastics units near sugarcane belts, feed mills near grain markets
3. Government: Integrate circular agriculture with existing schemes (e.g., link FPOs to bioenergy PPPs)

"When onion peels light homes and rice straw becomes packaging, waste becomes currency. India's circular economy revolution isn't coming—it's already here."

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